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**(54) PROCESS FOR PRODUCING DEFORMED NONWOVEN**

VERFAHREN ZUR HERSTELLUNG EINES VERFORMTEN VLIESTOFFES

PROCÉDÉ DE PRODUCTION DE NON-TISSÉ DÉFORMÉ

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**Description**

FIELD OF THE INVENTION

5 [0001] The present invention relates to a process for producing deformed nonwoven having deformations with high clarity.

BACKGROUND OF THE INVENTION

10 [0002] Nonwovens are widely used in a variety of absorbent articles for personal hygiene, such as disposable diapers for infants, training pants for toddlers, adult incontinence undergarments and/or sanitary napkins which are designed to absorb and contain body exudates, in particular large quantities of urine, runny bowel movement (BM) and/or menses.

[0003] Various nonwovens have been suggested for use as a component such as topsheets for absorbent articles from the standpoints of skin sensation, a feeling of dryness, comfort, absorption of expelled bodily fluids, and prevention of fluid flow-back.

15 [0004] It may be desirable that nonwovens have a visible image or pattern at least one surface thereof as considered that nonwoven having images or patterns may have a breathable appearance, and delight users with a unique pattern.

[0005] Frequently, nonwovens used as a component of absorbent articles are deformed to improve performance of the article as well as to provide aesthetic visual impression. In some instances, it may be desirable that deformations such as apertures, protrusion, and embossing have a clean and clear shape and a size regularity to provide a desirable visual quality and efficient handling of body exudates. It may be also desirable nonwovens comprise natural fibers or regenerated cellulose-based fibers. These fibers however do not behave like the synthetic fibers in deformation process. When nonwovens contain natural fibers or regenerated cellulose-based fibers, conventional mechanical aperturing process like pin aperturing as well as water jet aperturing may result in low quality apertures such as apertures having an insufficient small size, less number of apertures than intended to form, apertures in non-uniform aperture shapes and sizes, or apertures having a low clarity. All these may lead to unsatisfactory visual quality of the nonwovens and/or deteriorated body exudates handling.

20 [0006] US5919178A relates to methods for producing a thin absorbent structure by laying a layer of essentially superabsorbent material between two layers of defibered and moisturized cellulose pulp or tissue. The composite structure is calendared between one or more pairs of heated rolls, to bind the layer of superabsorbent material in itself and to the surrounding cellulose pulp layers or tissue layers.

[0007] US3881490A is concerned with thin, absorbent pads comprising a fluid pervious non-woven cover sheet, a central absorbent batt of comminuted wood pulp fibers, and a fluid-impervious backing element. The integrity of the central absorbent batt is maintained in the x and y directions by adhering the cover sheet and fluid impervious backing element to the respective top and bottom surfaces of the central batt by light applications of flexible adhesive, and in the z direction by hydrogen bonding of the wood pulp fibers in selected areas.

25 [0008] US5160582A discloses bulky processed sheets which are obtained from mixtures of crosslinked pulp and hot water-soluble fibers, or crosslinked pulp, thermally fusible fibers and binders. The sheets can be embossed by hot pressing them in wet state and treated with flame retardants.

30 [0009] US2012080155A1 relates to a water disintegratable fibrous sheet comprising 30-50% by mass of unbeaten pulp; 20-40% by mass of beaten pulp; 15-45% by mass of regenerated cellulose; and 2-15% by mass of fibrillated purified cellulose. All materials having a defined beating degree. The microfibers of the beaten pulp and the fibrillated purified cellulose are each entangled with the other fibers.

[0010] CN205711402U is concerned with a non-woven fabric containing cellulose fiber. The fabric exhibits compacted areas in combination with a certain transparency, moisture retention and longitudinal and transverse strength ratio in the wet state

35 [0011] As such, it is desirable to provide a process for producing deformed nonwovens having clean and clear deformations.

[0012] It is also desirable to provide a process for producing deformed nonwovens having deformations as designed.

50 SUMMARY OF THE INVENTION

[0013] The invention provides process for producing a deformed nonwoven as defined in the claims.

55 BRIEF DESCRIPTION OF THE DRAWINGS

[0014] In the drawings, like numerals or other designations designate like features throughout the views.

Fig. 1 is a schematic representation of a process according to the present invention for making a deformed nonwoven.

Fig. 2 is schematic representation of an example of deforming process.

Fig. 3 is a schematic representation of another process according to the present invention for making a deformed nonwoven.

Fig. 4 is a schematic representation of a hydroentanglement process.

Fig. 5 is a microscopic image of an apertured nonwoven (Nonwoven 1) produced by a pin aperturing process.

Fig. 6 is a microscopic image of an apertured nonwoven (Nonwoven 2) produced by a pin aperturing process.

Fig. 7 is a microscopic image of an apertured nonwoven (Nonwoven 4) produced by a pin aperturing process.

Fig. 8 is a microscopic image of an apertured nonwoven (Nonwoven 6) produced by a pin aperturing process.

Fig. 9 is a microscopic image of an apertured nonwoven (Nonwoven 7) produced by a pin aperturing process.

Fig. 10 is a microscopic image of an apertured nonwoven (Nonwoven 9) produced by a pin aperturing process.

Fig. 11 is a microscopic image of an apertured nonwoven (Nonwoven 10) produced by a pin aperturing process.

Fig. 12 is a microscopic image of an apertured nonwoven (Nonwoven 11) produced by a water-jet aperturing process.

Fig. 13 is a microscopic image of an embossed nonwoven (Nonwoven 12) produced by an embossing process.

Fig. 14 is a microscopic image of an embossed nonwoven (Nonwoven 13) produced by an embossing process.

#### DETAILED DESCRIPTION OF THE INVENTION

**[0015]** Various non-limiting forms of the present disclosure will now be described to provide an overall understanding of the principles of the structure, function, manufacture, and use of an absorbent article comprising back ears having unique engineering strain properties and low surface roughness. One or more examples of these non-limiting embodiments are illustrated in the accompanying drawings. Those ordinary skilled in the art will understand that the absorbent articles described herein and illustrated in the accompanying drawings are non-limiting example forms and that the scope of the various non-limiting forms of the present disclosure are defined solely by the claims. The features illustrated or described in connection with one non-limiting form may be combined with the features of other non-limiting forms. Such modifications and variations are intended to be included within the scope of the present disclosure.

**[0016]** "Absorbent article" refers to wearable devices, which absorb and/or contain liquid, and more specifically, refers to devices, which are placed against or in proximity to the body of the wearer to absorb and contain the various exudates discharged from the body. Absorbent articles can include diapers, training pants, adult incontinence undergarments, feminine hygiene products such as sanitary napkins and pantyliners, and wipes.

**[0017]** As used herein, the term "comprising" means that the various components, ingredients, or steps can be conjointly employed in practicing the present invention. Accordingly, the term "comprising" is open-ended and encompasses the more restrictive terms "consisting essentially of" and "consisting of".

**[0018]** The term "cellulose-based fibers", as used herein, intends to include both natural cellulose-based fibers, regenerated cellulose-based fibers such as rayon and viscose, and synthetic fibers that comprise cellulose-based content. Natural cellulose-based fibers include cellulosic matter such as wood pulp; seed hairs, such as cotton; stem (or bast) fibers, such as flax and hemp; leaf fibers, such as sisal; and husk fibers, such as coconut.

**[0019]** The term "deformation process", as used herein, means a process to change a material shape or density in at least one area in the material by applying stresses, heat, pressure, or strains.

**[0020]** The term "deformed nonwoven", as used herein, means a nonwoven comprising discrete deformations formed therein. The deformations may be features in the form of apertures, protrusions, depression (embossing), or any combinations thereof. These features may extend out from the surface on one side of the web, or from both of the surfaces of the web. Different features may be intermixed with one another.

**[0021]** The term "forming elements", as used herein, refers to any elements on the surface of a forming member such as a roll, plate and belt that are capable of deforming a nonwoven.

**[0022]** "Nonwoven" refers to a manufactured web of directionally or randomly orientated fibers, excluding paper and products which are woven, knitted, tufted, stitch-bonded incorporating binding yarns or filaments, or felted by wet-milling, whether or not additionally needed. Nonwoven materials and processes for making them are known in the art. Generally, processes for making nonwoven materials comprise laying fibers onto a forming surface, which can comprise spunlaying, meltblowing, carding, airlaying, wetlaying, coform and combinations thereof. The fibers can be of natural or man-made origin and may be staple fibers or continuous filaments or be formed in situ.

**[0023]** As used herein, the term "natural fibers" refers to elongated substances produced by plants and animals and comprises animal-based fibers and plant-based fibers. Natural fibers may comprise fibers harvested without any post-harvest treatment step as well as those having a posttreatment step, such as, for example, washing, scouring, and bleaching. As used herein, the term "plant-based fibers" comprises both harvested fibers and synthetic fibers that comprise bio-based content. Harvested plant-based fibers may comprise cellulosic matter, such as wood pulp; seed hairs, such as cotton; stem (or bast) fibers, such as flax and hemp; leaf fibers, such as sisal; and husk fibers, such as coconut.

Process for Producing Deformed Nonwoven

5 [0024] A process according to the present invention comprises adjusting a water content of a nonwoven in such a way that the nonwoven comprises at least one area having a water content of at least about 12% by weight of the nonwoven in the area, and subjecting the nonwoven to a mechanical deformation process, the deformation process comprising mechanical deformation of the nonwoven and dewatering of the nonwoven.

10 [0025] Referring to Fig. 1 depicting a simplified, schematic view of an exemplary process according to the present invention, nonwoven 20 is supplied to a water content adjustment unit 200 where a water content of nonwoven 20 is adjusted, so that the nonwoven 20 comprises at least one area having a water content of at least about 12%, or at least 20%, or at least about 30%, or at least about 40% by weight of the nonwoven in the area.

[0026] A water content of nonwoven 20 in the water content adjustment unit 200 may be adjusted by for example, applying moisture to nonwoven 20 or drying nonwoven 20 using any known and suitable method.

15 [0027] In some embodiments, a water content of a nonwoven may be adjusted by applying moisture to the nonwoven. As one example, a water content of a nonwoven may be adjusted by moisturizing a nonwoven utilizing a chamber equipped with a moisture generation machine to make the chamber is filled with moistures. Nonwoven is supplied to and goes through the chamber, and the nonwoven gets moisturized while it passes the chamber so that the nonwoven has a water content in a target range. As another example, a water content of a nonwoven can be adjusted by moisturizing a nonwoven utilizing a water pipe with a plurality of nozzles. The water pipe may be positioned above a nonwoven to be moisturized, and water spray is applied through the nozzles to apply water so that the nonwoven has a water content 20 in a target range. In some of such embodiments, the entire area of the nonwoven is moisturized.

25 [0028] In some embodiments, a water content of a nonwoven may be adjusted by drying the nonwoven to remove excess water from the nonwoven, for example when the process of the present invention is on-line process conducted continuously following hydroentanglement to produce a nonwoven web. Nonwoven from the hydroentanglement containing excess amount of water may be passed through a dewatering device such as a drying system where excess water is removed so that the nonwoven has a water content in a target range.

[0029] In some embodiments, a water content of at least one pre-determined region in a nonwoven may be adjusted by a positioned moisturizing process. For example, printing technology like flex printing or engraving printing well known in the industry can be used to print/supply water into specific determined region(s) on nonwoven so that the pre-determined regions are moisturized as desired.

30 [0030] Referring to Fig. 1, nonwoven 20 leaving the water content adjustment unit 200 may comprise at least one area having a water content of about at least 12%, or at least 20%, or at least about 30%, or at least about 40% by weight of the nonwoven in the area. In some embodiments, the entire area of nonwoven 20 is moisturized to have a water content of about at least 12%, or at least 20%, or at least about 30%, or at least about 40% by weight of the nonwoven. In other 35 embodiments, nonwoven 20 comprises a plurality of moisturized areas, each moisturized area having a water content about at least 12%, or at least 20%, or at least about 30%, or at least about 40% by weight of the nonwoven in the area. The moisturized areas may be pre-determined areas where deformations are formed. Without wishing to be bound by theory, a water content of nonwoven may affect to deformation quality. In nonwoven comprising cellulose-based fibers, the cellulose-based fibers in a dry condition are connected via hydrogen bonds. When the nonwoven absorbs enough moisture, hydrogen bonds connecting fibers are released and the fibers get more flexible to move, so that nonwoven 40 gets easier to be deformed.

[0031] Fibers forming the nonwoven 20 can be of natural or man-made origin and may be staple fibers or continuous filaments or be formed in situ. The nonwoven 20 comprises cellulose-based fibers at least 50%, or at least 90% by weight of the nonwoven. In one embodiment, 100% of fibers constituting the nonwoven 20 is cellulose-based fibers.

45 [0032] The nonwoven 20 may comprise a single layer. It may comprise two or more layers, which may form a unitary structure or may remain as discrete layers which may be attached at least partially to each other by, for example, thermal bonding, adhesive bonding or a combination thereof. A unitary structure herein intends to mean that although it may be formed by several sub-layers that have distinct properties and/or compositions from one another, they are somehow intermixed at the boundary region so that, instead of a definite boundary between sub-layers, it would be possible to identify a region where the different sub-layers transition one into the other. Such a unitary structure is typically built by 50 forming the various sub-layers one on top of the other in a continuous manner, for example using air laid or wet laid deposition. Typically, there is no adhesive used between the sub-layers of the unitary material. However, in some cases, adhesives and/or binders can be present although typically in a lower amount that in multilayer materials formed by separate layers.

[0033] The nonwoven 20 may has a basis weight of 20gsm-100gsm, or 25gsm-50gsm, or 30gsm-50gms.

55 [0034] Referring to Fig. 1, nonwoven 20 leaving the water content adjustment unit 200 is transferred to a deformation unit 300 where the nonwoven 20 is mechanically deformed and dewatered to produce a deformed nonwoven 30. Mechanical deformation of a nonwoven may be conducted using a mechanical deformation apparatus. Mechanical deformation apparatuses forming embossing and/or apertures are well known in the art such as WO2011/090974 and

WO2015/134359. In some embodiments, a deformation process may comprise subjecting a nonwoven to a deformation apparatus, the deformation apparatus comprising a first forming member and a second forming member, and moving the nonwoven through a nip that is formed between the first and second forming members so that deformations are formed in the nonwoven as the first forming member and the second forming member are engaged. Although the apparatuses will be described herein for convenience primarily in terms of rolls, it should be understood that the description will be applicable to forming structures comprising a forming member that have any other suitable configurations.

**[0035]** Fig. 2 is a schematic illustration of an example of mechanical deformation of nonwoven not according to the invention.

**[0036]** A nonwoven 20 is passed through a nip 502 formed by a pair of rolls 500, two intermeshing rolls 504 and 506, to form deformations in nonwoven web 20. The first roll 504 may comprise a plurality of first elements such as protrusions extending outwardly from the first roll 504. The first elements on the first roll 504 may be various in a size, shape, height, area, width and/or dimension which may determine the size, shape and dimension of deformations such as apertures and embossing. The second roll 506 may have a flat surface. Or, the second roll 506 may comprise grooves intermeshing with the protrusions of the first roll 504. When the nonwoven 20 comprises thermoplastic fibers, at least one of the rolls 504 and 506 may be heated to a temperature to soften fibers constituting the nonwoven 20 but lower than the melting point the fibers. When the fiber comprises a sheath/core type bicomponent, at least one of the rolls 504 and 506 may be heated to a temperature higher than the melting point of the sheath polymer. In some embodiments, a first roll 504 may create the apertures (in combination with the second roll) and a second roll 506 may create projections (in combination with the first roll) in the nonwoven 20. The first roll 506 may comprise a plurality of first forming elements such as teeth, and a plurality of second recesses formed in a radial outer surface of the first roll 504. The second roll 506 may comprise a plurality of second forming element extending radially outwardly from the second roll 506 configured to at least partially engage with the second recesses in the first roll 504.

**[0037]** The nonwoven 20 mechanically deformed is dewatered to produce a deformed nonwoven. The nonwoven 20 may be dewatered by introducing heat to the nonwoven to evaporate at least part of water the nonwoven contains. Any of various heat sources known in the nonwoven manufacturing process such as a heated roller, oven, burner, and/or infrared radiation, and any combination thereof can be employed to introduce heat to the nonwoven to evaporate the water. For example, heat may be introduced to the nonwoven by directly contacting a heat source such as a heated roller to the nonwoven. Or, heat may be introduced to the nonwoven by providing a hot air using an oven, a burner, or infrared radiation source. The nonwoven 20 may be dewatered by providing compression to the nonwoven. The dewatered nonwoven may have a water content less than about 20%, or less than about 15%, or less than about 12%, or less than about 10%. Without wishing to be bound by theory, prompt reduction of moisture (or water) in the mechanically deformed nonwoven while deformations formed in the nonwoven are maintained results in formation of new hydrogen bonds among fibers which may stabilize the deformation.

**[0038]** In the mechanical deformation process of the present invention, mechanical deformation of a nonwoven may be conducted prior to dewatering the nonwoven. Or, mechanical deformation and dewatering a nonwoven may be carried out simultaneously. In some embodiments, referring to Fig. 2, the deformation process suitable for the present invention comprises subjecting the nonwoven to a deformation apparatus, the deformation apparatus comprising a first forming member and a second member, wherein the first forming member comprises first forming elements on its surface, wherein at least one of the first forming member and the second forming member is heated, and moving the nonwoven through a nip that is formed between the first and second forming members so that deformations are formed in the nonwoven as the first forming member and the second forming member are engaged, wherein the nonwoven contacts the first and second forming members for sufficient time the deformations are formed and dewatering of the nonwoven occurs.

**[0039]** The deformation process comprises a pin-aperturing process. Referring to Fig. 2, a first roll 504 may comprise a plurality of first forming elements such as teeth being tapered from a base and a tip, the teeth being joined to the first roll. The second roll 506 may comprise a plurality of first recesses which intermesh with the first forming elements on the first roll at the nip. At least one of the rolls 504 and 506 may be heated to introduce enough heat to the nonwoven during a contact time to form apertures as intended and the moisture in the nonwoven can be evaporated. A roll temperature may be determined considering a contact time of the nonwoven and the heated roll. Though a low temperature such as 50°C may be employed with an extended contact time, it may not be efficient applying to a high speed deformation process. Given a trend of high nonwoven production process, the first and/or second forming member such as a roll may be heated to a temperature higher than 70°C, or higher than 80°C, or higher than 100°C, or higher than 110°C, or higher than 120°C.

**[0040]** Referring to Fig. 1, the deformed nonwoven 30 is optionally subjected to a drying unit 400 to further dry the deformed nonwoven 30. The deformed nonwoven 30 may be further dried to have a water or other solution content, less than about 12%, less than about 10%, or less than about 5% by weight to prevent an issue due to microorganism growth.

**[0041]** In some embodiments, a process of the present invention comprises (a) subjecting a fibrous web to an entan-

gument process to obtain a nonwoven, (b) adjusting a water content of the nonwoven in such a way that the nonwoven comprises at least one area having a water content of at least 12% by weight of the nonwoven, and (c) subjecting the nonwoven to a mechanical deformation process to produce a deformed nonwoven. The entanglement process is a hydroentanglement process or a needle punching process. The (b) and the (c) steps may be carried out simultaneously.

5 **[0042]** Fig. 3 depicts a simplified, schematic view of another exemplary process according to the present invention. Referring to Fig. 3, a fibrous web 10 is supplied to an entanglement unit 100 for fiber entanglement to produce a nonwoven web 20. The nonwoven 20 is supplied to a water content adjustment unit 200 where a water content of the nonwoven 20 is adjusted so that the nonwoven 20 comprises at least one area having a water content of a least about 12% by weight of the nonwoven in the area. The nonwoven 20 is subjected to a deformation unit 300 to mechanically deform the nonwoven and dewater the nonwoven. Still referring to Fig. 3, the deformed nonwoven 30 may be subjected to a drying unit 400 to dry the deformed nonwoven 30 to have a water content of less than 10% by weight of the nonwoven.

10 **[0043]** The fiber entanglement in the entanglement unit 100 can be carried out by any method known for fiber entanglement such as a needle punching method, a hydro-entangling method, a water vapor flow (steam jetting) entangling method, and the like. In some embodiments, the fiber entanglement is carried out using a hydroentangling method.

15 **[0044]** Descriptions with respect to the deformation process and drying process with respect to the process of Fig. 1 above apply to the process of Fig. 3.

20 **[0045]** Fig. 4 depicts a simplified, schematic view of one example hydroentangled nonwoven manufacturing process. As is generally known in the art, hydroentanglement (sometimes referred to as spunlacing, jet entanglement, water entanglement, hydroentanglement or hydraulic needling), is a mechanical bonding process whereby fibers of a nonwoven web are entangled by means of high pressure water jets. Patterning can be achieved by use of patterned drums or belts which cause the fibers to form a negative image of the drum design in the fabric. The formed web of various fibrous components (usually airlaid, wetlaid, or carded, but sometimes spunbond or melt-blown, etc.) can first be compacted and prewetted to eliminate air pockets and then water-needed. With reference to Fig. 4, a fibrous web 10 upstream of a jet head 32 passes under the jet head 32 and go through hydroentanglement. During the entanglement process, the fibrous web 10 is passed by the jet head 32 that comprises a plurality of injectors that are positioned to generally form a water curtain (for simplicity of illustration, only one injector 34 is illustrated in Fig. 4). A water jet 36 is directed through the fibrous web 10 at high pressures, such as 150 or 400 bar. As is to be appreciated, while not illustrated, multiple rows of injectors 34 are typically used, which can be positioned on one or both sides of the fibrous web 10.

25 **[0046]** Hydroentangled nonwoven 20 can be supported by any suitable support system 39, such as a moving wire screen (as illustrated) or on a rotating porous drum, for example. While not illustrated, it is to be appreciated that hydroentanglement systems can expose the fibrous web 10 to a series of jet heads 32 along the machine direction, with each delivering water jets at different pressures. The particular number of jet heads 32 utilized can be based on, for example, desired basis weight, degree of bonding required, characteristics of the web, and so forth. As the water jet 36 penetrates the web, a suction slot 38 positioned proximate beneath the fibrous web 10 collects the water so that it can be filtered and returned to the jet head 32 for subsequent injection. The water jet 36 delivered by the jet head 32 exhausts most of its kinetic energy primarily in rearranging fibers within the fibrous web 10 to turn and twist the fibers to form a series of interlocking knots.

30 **[0047]** Once the fibrous web 10 has been hydroentangled, the nonwoven 20 is then passed through a dewatering device 42 where excess water is removed. The dewatering device 42 can be any suitable dewatering system including a drying system such as a multi-segment multi-level bed dryer, a vacuum system, and/or an air drum dryer, for example. The dewatering device 42, serves to dewater and dry the nonwoven 20, so that the nonwoven 20 has a water content (in the range of from about 20wt% to about 70wt%). The deformed nonwoven 30 after being dried may be further treated with additional heat especially when the nonwoven includes synthetic fibers. The synthetic fibers begin to soften, and these softened fibers touch each other, bonds will form between the fibers, thereby increasing the overall flexural rigidity of the structure due to the formation of these bond sites.

#### Deformed Nonwoven

35 **[0048]** Deformed nonwoven produced by a process according to the present invention may provide apertures exhibiting a high geometric quality such that more numbers of apertures having an intended size as compared to the apertures of the comparative examples. In addition, deformed nonwoven produced by a process according to the present invention may provide apertures having higher clarity when indicated as a percent occlusion. Without wishing to be bound by theory, it is believed that increased deformation numbers in a given apertured pattern and deformation clarity may result in a deformed nonwoven with improved bodily exudate handling performance as well as an improved visible perception, and increased robustness during the manufacture of absorbent articles or apertured nonwoven webs.

40 **[0049]** Fig. 5 is a microscopic image of a related art deformed nonwoven 30 (Nonwoven 1) apertured by a conventional pin aperturing process where a water content of a nonwoven was not adjusted. Figs. 6-11 are microscopic images of deformed nonwovens, Nonwovens 2, 4, 6, 7, 9 and 10, respectively, produced by a process according to the present

invention. Figs. 2-10 has an image size of 31mm x 26mm, and Fig. 11 has an image size of 37mm x 33mm.

**[0050]** Nonwovens 2-10 of the present invention have more numbers of quality apertures in a given aperture pattern than deformed Nonwoven 1 produced using the same toolings. Given Nonwovens 1-9 were produced using the same toolings with a pin pattern intended to form an identical aperture pattern with the same number of target apertures, the nonwovens were supposed to have the same number of apertures in a given pattern. Deformed nonwoven produced by a process according to the present invention may have a high aperture rate, measured according to Aperture Quality Test under MEASUREMENT, such as higher than 30%, higher than 50%, higher than 60%, higher than 70, higher than 80%, higher than 90%, and higher than 95% when the aperture rate is defined as below.

$$\text{Aperture rate} = (\text{number of quality apertures/number of target apertures}) \times 100$$

**[0051]** The number of target apertures herein means the total number of apertures intended to form which may be determined by tooling designs such as number of pins in a pin-aperturing apparatus.

**[0052]** This high aperture rate may be important when designing aperture patterns as aperture patterns are important both for visual quality as well as for robustness of the nonwoven web, especially during the process of manufacturing an absorbent article, and aiding in distribution of strain evenly across a nonwoven web, aiding in robustness while under strain during a manufacturing process.

**[0053]** Fig. 12 is a microscopic image (image size: 36mm x 20mm) of a related art nonwoven, Nonwoven 11, apertured by a water jet aperturing process where apertures exhibit stray fibers extending across the apertures.

**[0054]** Referring Figs. 6-11, deformations, apertures in these cases, of deformed nonwoven 30 produced by the process of the present invention may have improved aperture clarity as compared to those of the related art such as water jet aperturing process. In other words, the deformed nonwoven 30 may be substantially less fibers extending across or into the plurality of apertures. This may improve desirable visual quality, and provide for better bodily exudate acquisition in that the aperture opening is large enough to overcome the surface tension of the bodily exudate. The plurality of apertures in nonwovens produced by a process according to the present invention having fewer fibers extending therethrough or thereacross may lead to improved bodily exudate acquisition, especially in a hydrophobic nonwoven topsheet context. If a hydrophobic fiber or fibers extend(s) across, partially across, or into an aperture, this may effectively reduce the size of the aperture, and potentially cause reduced bodily exudate acquisition by providing a small aperture opening. As such, the plurality of apertures formed by a process of the present invention may be about 6% or less occluded, or 5% or less occluded, or 4.5% or less occluded, according to the Aperture Clarity Test as described below.

**[0055]** Deformed nonwoven produced by a process according to the present may comprise a second plurality of deformations, such that a first plurality of apertures and the second plurality of apertures forming zones in the deformed nonwoven. Each zone may comprise a plurality of apertures that may exhibit a highly regular geometric quality such that there is little variance in the shape and/or size of one aperture as compared to another aperture within the same zone, but the aperture size and/or shape varies between zones.

**[0056]** The deformed nonwoven according to the present invention can be incorporated into, for example, an absorbent article. For example, an absorbent article may have a component such as a topsheet and/or an outer most sheet comprising the deformed nonwoven.

**[0057]** The deformed nonwoven may comprise a plurality of apertures or a plurality of embosses over the entirety of the nonwoven, or may comprise a plurality of apertures or embosses over one or more discrete areas or zones of the nonwoven. The nonwoven may comprise two or more zones which each define a plurality of apertures or a plurality of embosses, and the apertures or the emboss exhibiting a high degree of regularity in shape and size within each zone, but having different sizes and/or different shapes between the zones. The apertures or embosses may also form any fanciful pattern in the nonwoven.

#### Absorbent Article

**[0058]** The present invention also provides an absorbent article comprising a layer comprising a nonwoven or a laminate according to the present invention.

**[0059]** The absorbent article of the present invention may comprise a topsheet and a backsheets joined to the topsheet. The absorbent article of the present invention may further comprise an absorbent core disposed between the topsheet and the backsheets. In some embodiments, the absorbent article of the present invention comprises a topsheet or a layer disposed below the topsheet comprising a nonwoven or a laminate according to the present invention.

**[0060]** The absorbent articles of the present invention may be produced industrially by any suitable means. The different layers may thus be assembled using standard means such as embossing, thermal bonding, gluing or any combination thereof.

Topsheet

5 **[0061]** Topsheet can catch body fluids and/or allow the fluid penetration inside the absorbent article. With the nonwoven according to the present invention, the first web layer is preferably, disposed on a side in contact with the skin.

Backsheet

10 **[0062]** Any conventional liquid impervious backsheet materials commonly used for absorbent articles may be used as backsheet. In some embodiments, the backsheet may be impervious to malodorous gases generated by absorbed bodily discharges, so that the malodors do not escape. The backsheet may or may not be breathable.

Absorbent core

15 **[0063]** It may be desirable that the absorbent article further comprises an absorbent core disposed between the topsheet and the backsheet. As used herein, the term "absorbent core" refers to a material or combination of materials suitable for absorbing, distributing, and storing fluids such as urine, blood, menses, and other body exudates. Any conventional materials for absorbent core suitable for absorbent articles may be used as absorbent core.

MEASUREMENT

20 1. Water content Measurement

**[0064]** Water content is measured using ISO method ISO 287:2017 specifying an oven-drying method for the determination of the water content of nonwoven.

25 2. Microscopic Image

30 **[0065]** Microscopic images of specimens are taken using an Optical Microscope such as VR-3200 (KEYENCE, Japan) or equivalent. An appropriate magnification and working distance are chosen such that the aperture is suitably enlarged for measurement. The image is analyzed using ImageJ software (version 1.52e or above, National Institutes of Health, USA) to measure an aperture size.

3. Aperture Quality Test

35 (1) Sample Preparation

40 **[0066]** When a nonwoven is available in a raw material form, a specimen with a size of 50 mm x 50 mm is cut from the raw material. When a nonwoven is a component of a finished product, the nonwoven is removed from the finished product using a razor blade to excise the nonwoven from other components of the finished product to provide a nonwoven specimen with a size of 50 mm x 50 mm. A cryogenic spray (such as Cyto-Freeze, Control Company, Houston TX) may be used to remove the nonwoven specimen from other components of the finished product, if necessary.

(2) Image Generation

45 **[0067]** Aperture quality such as aperture size, aperture aspect ratio, aperture rate, and aperture clarity measurements for a nonwoven are performed on images generated by placing the specimen flat against a dark background under uniform surface lighting conditions and acquiring a digital image using an optical microscope such as Keyence 3D Measurement System VR-3200 or equivalent. Analyses are performed using image analysis program such as ImageJ software (version 1.52p or above, National Institutes of Health, USA) and equivalent. The image needs to be distance calibrated with an image of the ruler to give an image resolution, i.e. 67.8 pixels per mm. After performing an auto-focus step, the microscope acquires a specimen image with a rectangular field of view that includes an aperture region, which is a region containing i) one entire discrete apertured pattern, or ii) at least 35mm x 20mm area containing at least 20apertures, whichever is available.

55 (3) Image Analysis - Binary Image

**[0068]** Open a specimen image in ImageJ. Convert the image type to 8 bit. The 8-bit grayscale image is then converted to a binary image (with "black" foreground pixels corresponding to the aperture regions) using the "Minimum" thresholding

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method: If the histogram of gray level (GL) values (ranging from 0 to 255, one bin with propensity  $P_i$  per gray level  $i$ ) has exactly two local maxima, the threshold gray level value  $t$  is defined as that value for which  $P_{t-1} > P_t$  and  $P_t \leq P_{t+1}$ . If the histogram has greater than two local maxima, the histogram is iteratively smoothed using a windowed arithmetic mean of size 3, and this smoothing is performed iteratively until exactly two local maxima exist. The threshold gray level value  $t$  is defined as that value for which  $P_{t-1} > P_t$  and  $P_t \leq P_{t+1}$ . This procedure identifies the gray level (GL) value for the minimum population located between the dark pixel peak of openings and the lighter pixel peak of the specimen material. If the histogram contains either zero or one local maximum, the method cannot proceed further, and no output parameters are defined.

### 10 (4) Aperture Size, Aspect Ratio, Aperture Rate and Opening Rate

**[0069]** Set the scale according to the image resolution. Create a filtered image by removing small openings in the binary image obtained in (3) Image Analysis above using an outlier removing median filter, which replaces a pixel with median of the surrounding area of 5 pixels in radius if the pixel is darker than the surrounding. Create a second filtered image based on the first one by removing stray fibers in the binary image using an outlier removing median filter, which replaces a pixel with the median of the surrounding area of 5 pixels in radius if the pixel is brighter than the surrounding. Set the measurements to include the analysis of aperture area and shape descriptor (i.e. aspect ratio, which is the ratio between the major and minor axis length of a fitted ellipse, after replacing an area selection with the best fit ellipse by keeping the same area, orientation and centroid as the original selection). Obtain the area and aspect ratio values of selected openings ("quality apertures") after tracing openings by their outer edge and excluding the openings with size below 0.10 mm<sup>2</sup> and incomplete openings at the edge of acquired image.

#### (4-1) Aperture Size

**[0070]** Area values for all the quality apertures are analyzed to calculate the mean and standard deviation of the aperture size to the nearest 0.01 mm<sup>2</sup>. The mean aperture size is reported as aperture size. The relative standard deviation (RSD, defined as the standard deviation divided by the mean and multiplied by 100) of the area values for all the quality apertures is calculated to the nearest 1%.

#### 30 (4-2) Aspect Ratio

**[0071]** Aspect ratio values for all the quality apertures are analyzed to calculate the mean and standard deviation of the aspect ratio to the nearest 0.01 as describing the aperture shape. The mean aspect ratio is reported as aspect ratio. The relative standard deviation (RSD, defined as the standard deviation divided by the mean and multiplied by 100) of the aspect ratio values for all the quality apertures is calculated to the nearest 1%.

#### (4-3) Aperture Rate

**[0072]** Aperture rate is obtained by the equation below.

$$\text{Aperture rate} = (\text{number of quality apertures} / \text{number of target apertures}) \times 100$$

**[0073]** The number of target apertures herein means the total number of apertures intended to form which may be determined by tooling designs such as number of pins in a pin-aperturing apparatus. The number of quality apertures is divided by the number of target apertures and multiplied by 100 to give the result of aperture rate. Prepare and analyze a total of five substantially similar replicate samples. The reported values will be the arithmetic mean of the five replicate samples to the nearest 1%.

#### 50 (4-4) Opening Rate

**[0074]** Divide the sum of the area values of all the quality apertures by the area of the rectangular field of view for one specimen image, and multiplied by 100 to calculate the opening rate. Prepare and analyze a total of five replicate samples in the same view size. The reported values will be the arithmetic mean of the five replicate samples to the nearest 0.01%.

#### 55 (5) Aperture Clarity

**[0075]** Aperture clarity is determined by the measurement of percent occlusion (i.e. the percentage of the aperture

area occluded by stray fibers.) Create a filtered image by removing small openings in the binary image generated in (3) Image Analysis - Binary Image using an outlier removing median filter, which replaces a pixel with the median of the surrounding area of 6 pixels in radius if the pixel is darker than the surrounding. Remove the stray fibers from apertures using a morphological closing filter, which performs a dilation operation followed by an erosion operation under the settings of one adjacent foreground (or background) pixel for dilation (or erosion) and pad edges when eroding, before filling the remaining holes in the apertures. Subtract the original binary image from the filtered image, keeping only positive values to show the stray fibers within apertures and measure the total area of stray fibers. The total area of stray fibers is then divided by the total area of apertures from the filtered image and multiplied by 100 to give the result of percent occlusion reported as aperture clarity to the nearest 0.01%.

## EXAMPLES

### Example 1: Preparation of Deformed Nonwovens

**[0076]** Nonwoven 1: 35gsm spunlace 100% cotton nonwoven (CHTC, China) without moisturizing was supplied. Water content of the nonwoven measured by Water content Measurement disclosed herein, was 8% by weight of the nonwoven. The nonwoven was continuously proceeded with a pin aperturing process using an apparatus to form a plurality of apertures to obtain nonwoven 1. A temperature of pins in the apparatus was 105°C, and contact time of the nonwoven at tooling was 20 seconds. Fig. 5 is a microscopic image of nonwoven 1 taken according to the Microscopic Image under MEASUREMENT.

**[0077]** Nonwoven 2: 35gsm spunlace 100% cotton nonwoven was supplied and moisturized so that the nonwoven has a water content of 20%. The nonwoven was continuously proceeded with a pin aperturing process using the same aperturing apparatus and process as used to produce nonwoven 1. Fig. 6 is a microscopic image of Nonwoven 2 taken according to the Microscopic Image under MEASUREMENT.

**[0078]** Nonwovens 3-5: Nonwovens 3-5 were produced using the same nonwoven, aperturing apparatus and process as used to produce Nonwoven 2 except for using water contents of 32%, 40% and 53%, respectively. Fig. 7 is a microscopic image of Nonwoven 4 taken according to the Microscopic Image under MEASUREMENT.

**[0079]** Nonwoven 6: Nonwoven 6 was produced using the same aperturing apparatus and process as used to produce nonwoven 2 except using 35gsm 100% rayon (from Beijing Dayuan) instead of 35gsm 100% cotton and a water content of 55%. Fig. 8 is a microscopic image of Nonwoven 6 taken according to the Microscopic Image herein.

**[0080]** Nonwovens 7-9: Nonwovens 7-9 were produced using the same nonwoven, aperturing apparatus and process used to produce Nonwoven 2 under deformation conditions described in Table 1 below. Figs. 9 and 10 are microscopic images of Nonwovens 7 and 9 respectively taken according to the Microscopic Image under MEASUREMENT.

**[0081]** Nonwoven 10: Nonwoven 10 was produced using 35gsm spunlace 100% cotton nonwoven by moisturizing the nonwoven to have a water content of 16%, and conducting a pin-aperturing under deformation conditions described in Table 1. Fig. 11 is a microscopic image of Nonwoven 10 taken according to the Microscopic Image under MEASUREMENT.

**[0082]** Nonwoven 11: 35gsm 100% cotton nonwoven was produced using a water jet punching process to obtain nonwoven 11. Fig. 12 is a microscopic image of Nonwoven 11 taken according to the Microscopic Image under MEASUREMENT.

**[0083]** Nonwovens 12 and 13: Embossed Nonwovens 12 and 13 were produced using 35gsm spunlace 100% cotton nonwoven, and the same embossing apparatus and process except for water contents (8% in Nonwoven 12 and 32% in Nonwoven 13) of nonwoven as indicated in Table 1 below. Figs. 13 and 14 are microscopic images (image size: 35mm x 11mm) of Nonwovens 12 and 13, respectively, taken according to the Microscopic Image under

MEASUREMENT.

### Example 2: Nonwoven Characteristics

**[0084]** Number of quality apertures, aperture sizes, aspect ratios, aperture rates, aperture clarity (occlusion) of nonwovens produced in Example 1 were measured according to Aperture Quality Test under MEASUREMENT, and are indicated in Table 1 below.

**[0085]** Image field-of-view sizes are 31mm x 26mm for Nonwovens 1-9; 37mm x 33mm for Nonwoven 10; 36mm x 20mm for Nonwoven 11; and 35mm x 11mm for Nonwovens 12 and 13.

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Table 1

| Nonwoven                         | 1              | 2      | 3    | 4      | 5    | 6      | 7      |
|----------------------------------|----------------|--------|------|--------|------|--------|--------|
| Deformation process              | Pin aperturing |        |      |        |      |        |        |
| NW Water content (%)             | 8              | 20     | 32   | 40     | 53   | 55     | 44     |
| Pin temperature (°C)             | 105            | 105    | 105  | 105    | 105  | 105    | 48     |
| Contact time (s)                 | 20             | 20     | 20   | 20     | 20   | 20     | 300    |
| Image                            | Fig. 5         | Fig. 6 |      | Fig. 7 |      | Fig. 8 | Fig. 9 |
| No. of target aperture           | 39             | 39     | 39   | 39     | 39   | 39     | 39     |
| No. of quality aperture          | 9              | 10     | 26   | 37     | 34   | 40     | 38     |
| Aperture rate (%)                | 23             | 26     | 67   | 95     | 87   | >100   | 97     |
| Aperture size (mm <sup>2</sup> ) | 0.16           | 0.23   | 0.35 | 0.61   | 0.63 | 0.98   | 0.56   |
| SD of size (mm <sup>2</sup> )    | 0.05           | 0.12   | 0.16 | 0.21   | 0.30 | 0.32   | 0.24   |
| Aspect ratio                     | 1.57           | 1.42   | 1.31 | 1.21   | 1.27 | 1.20   | 1.37   |
| SD of Aspect Ratio               | 0.26           | 0.10   | 0.19 | 0.19   | 0.29 | 0.21   | 0.51   |
| Opening Rate (%)                 | 0.18           | 0.29   | 1.16 | 2.80   | 2.66 | 4.87   | 2.62   |
| Occlusion (%)                    | 6.50           | 5.93   | 5.36 | 4.41   | 5.02 | 4.15   | 5.74   |

Table 1- continued

| Nonwoven                         | 8              | 9       | 10      | 11                   | 12        | 13        |
|----------------------------------|----------------|---------|---------|----------------------|-----------|-----------|
| Deformation process              | Pin aperturing |         |         | Water-jet aperturing | embossing | embossing |
| NW Water content (%)             | 40             | 40      | 16      | NA                   | 8         | 32        |
| Pin temperature (°C)             | 78             | 88      | 150     | NA                   | 116       | 116       |
| Contact time (s)                 | 20             | 20      | 0.5     | NA                   | 10        | 10        |
| Image                            |                | Fig. 10 | Fig. 11 | Fig. 12              | Fig. 13   | Fig. 14   |
| No. of target aperture           | 39             | 39      | 42      |                      | -         | -         |
| No. of quality aperture          | 29             | 30      | 42      | 40                   | -         | -         |
| Aperture rate (%)                | 74             | 77      | 100     |                      | -         | -         |
| Aperture size (mm <sup>2</sup> ) | 0.43           | 0.40    | 1.03    | 0.55                 |           |           |
| SD of size (mm <sup>2</sup> )    | 0.25           | 0.21    | 0.24    | 0.52                 |           |           |
| Aspect ratio                     | 1.49           | 1.34    | 1.25    | 3.32                 |           |           |
| SD of aspect ratio               | 0.59           | 0.18    | 0.17    | 1.50                 |           |           |
| Opening rate (%)                 | 1.56           | 1.49    | 3.53    | 3.04                 | -         | -         |
| Occlusion (%)                    | 3.28           | 4.15    | 4.89    | 9.17                 | -         | -         |

**[0086]** Nonwovens 2-9 produced by a process according to the present invention have more apertures than Nonwoven 1 produced by a related art using the same aperturing device.

**[0087]** Nonwovens 2-10 produced by a process according to the present invention have a higher aperture rate than Nonwoven 1 produced by a related art.

**[0088]** Nonwovens 2-10 produced by a process according to the present invention have a lower aspect ratio than Nonwovens 1 and 11 produced by related art.

**[0089]** Nonwovens 2-10 produced by a process according to the present invention have apertures with higher aperture clarity than Nonwovens 1 and 11 produced by relative art.

[0090] Nonwoven 13 produced by a process not according to the present invention has more clear embossing than Nonwoven 12 produced by a related art using the same embossing device.

5 **Claims**

1. A process for producing a deformed nonwoven comprising at least 50% cellulose-based fibers by weight of the nonwoven, the process comprising;
  - 10 (a) adjusting a water content of a nonwoven in such a way that the nonwoven comprises at least one area having a water content of at least about 12% by weight of the nonwoven in the area, and
  - (b) subjecting the nonwoven to a mechanical deformation process, the deformation process comprising mechanical deformation of the nonwoven and dewatering of the nonwoven to obtain a deformed nonwoven; wherein the deformation process comprises a pin-aperturing process.
- 15 2. The process of claim 1, wherein the dewatering is conducted by introducing heat to the nonwoven.
3. The process of claim 1, wherein the mechanical deformation and the dewatering are carried out simultaneously.
- 20 4. The process of any of the preceding claims, wherein the cellulose-based fibers are fibers selected from the group consisting of cotton fibers, regenerated cellulose fibers and a combination thereof.
5. The process of any of the preceding claims, wherein the mechanical deformation of the nonwoven is carried out by a process comprising:
  - 25 (i) subjecting the nonwoven to a deformation apparatus, the deformation apparatus comprising a first forming member and a second forming member, wherein the first forming member comprises first forming elements on its surface, wherein at least one of the first forming member and the second forming member is heated, and
  - 30 (ii) moving the nonwoven through a nip that is formed between the first and second forming members so that deformations are formed in the nonwoven as the first forming member and the second forming member are engaged.
6. The process of claim 5, wherein the deformation apparatus comprises a pair of rolls.
- 35 7. The process of claim 5 or 6, wherein the nonwoven contacts the first and second forming members for sufficient time the deformations are formed and dewatering of the nonwoven occurs.
8. The process of claim 1 or 2, wherein the mechanical deformation is conducted prior to the dewatering.
- 40 9. The process of any of the preceding claims, the heat is introduced by a source selected from the group consisting of a heated roller, oven, burner, infrared radiation, and combinations thereof.
10. The process of any of the preceding claims, wherein the nonwoven comprises a spunlace web.
- 45 11. The process of any of the preceding claims, wherein the water content of a nonwoven is adjusted by applying moisture to the nonwoven.
12. The process of any of the preceding claims, wherein the water content of a nonwoven is adjusted by applying moisture to a pre-determined area in the nonwoven.
- 50 13. The process of any of claims 1-10, wherein the water content of a nonwoven is adjusted by drying the nonwoven.
14. The process according to any of the preceding claims, wherein the process further comprises (c) drying the deformed nonwoven, so that the deformed nonwoven has a water content of less than about 12% by weight of the deformed nonwoven.
- 55 15. The process according to any of the preceding claims, wherein the nonwoven comprises a first layer comprising cellulose-based fibers and a second layer comprising thermoplastic fibers.

16. The process according to claim 1, wherein the process further comprises subjecting a fibrous web to an entanglement process to obtain a nonwoven.

5 17. The process according to claim 16, wherein the entanglement process is a hydroentanglement process or a needle punching process.

18. The process according to claim 16 or 17, wherein the mechanical deformation and the dewatering are carried out simultaneously.

10

### Patentansprüche

1. Verfahren zum Herstellen eines verformten Vlieses, umfassend mindestens 50 Gew.-% zellulosebasierte Fasern des Vlieses, das Verfahren umfassend;

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(a) Einstellen eines Wassergehalts eines Vlieses derart, dass das Vlies mindestens einen Bereich umfasst, der einen Wassergehalt von mindestens etwa 12 Gew.-% des Vlieses in dem Bereich aufweist, und

(b) Unterziehen des Vlieses einem mechanischen Verformungsverfahren, das Verformungsverfahren umfassend eine mechanische Verformung des Vlieses und ein Entwässern des Vlieses, um ein verformtes Vlies zu erhalten;

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wobei das Verformungsverfahren ein Stiftöffnungsverfahren umfasst.

2. Verfahren nach Anspruch 1, wobei das Entwässern durch ein Einleiten von Wärme in das Vlies erfolgt.

25

3. Verfahren nach Anspruch 1, wobei die mechanische Verformung und das Entwässern gleichzeitig ausgeführt werden.

4. Verfahren nach einem der vorstehenden Ansprüche, wobei die zellulosebasierten Fasern Fasern sind, die aus der Gruppe ausgewählt sind, bestehend aus Baumwollfasern, regenerierten Zellulosefasern und einer Kombination davon.

30

5. Verfahren nach einem der vorstehenden Ansprüche, wobei die mechanische Verformung des Vlieses durch ein Verfahren ausgeführt wird, umfassend:

35

(i) Unterziehen des Vlieses einer Verformungsvorrichtung, die Verformungsvorrichtung umfassend ein erstes Formelement und ein zweites Formelement, wobei das erste Formelement erste Formelemente auf seiner Oberfläche umfasst, wobei mindestens eines von dem ersten Formelement und dem zweiten Formelement erwärmt wird, und

(ii) Bewegen des Vlieses durch einen Spalt, der zwischen dem ersten und dem zweiten Formelement ausgebildet ist, sodass bei einem Ineingriffnehmen des ersten Formelements und des zweiten Formelements Verformungen in dem Vlies ausgebildet werden.

40

6. Verfahren nach Anspruch 5, wobei die Verformungsvorrichtung ein Paar von Walzen umfasst.

45

7. Verfahren nach Anspruch 5 oder 6, wobei das Vlies ausreichend lange mit dem ersten und zweiten Formelement in Kontakt ist, bis die Verformungen ausgebildet sind und das Entwässern des Vlieses stattfindet.

8. Verfahren nach Anspruch 1 oder 2, wobei die mechanische Verformung vor dem Entwässern durchgeführt wird.

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9. Verfahren nach einem der vorstehenden Ansprüche, wobei die Wärme durch eine Quelle zugeführt wird, die aus der Gruppe ausgewählt ist, bestehend aus einer erwärmten Walze, einem Ofen, einem Brenner, Infrarotstrahlung und Kombinationen davon.

10. Verfahren nach einem der vorstehenden Ansprüche, wobei das Vlies ein Spunlacing-Gewebe umfasst.

55

11. Verfahren nach einem der vorstehenden Ansprüche, wobei der Wassergehalt eines Vlieses durch ein Auftragen von Feuchtigkeit auf dem Vlies eingestellt wird.

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12. Verfahren nach einem der vorstehenden Ansprüche, wobei der Wassergehalt eines Vlieses durch das Auftragen von Feuchtigkeit auf einem vorbestimmten Bereich in dem Vlies eingestellt wird.
- 5 13. Verfahren nach einem der Ansprüche 1 bis 10, wobei der Wassergehalt eines Vlieses durch ein Trocknen des Vlieses eingestellt wird.
- 10 14. Verfahren nach einem der vorstehenden Ansprüche, wobei das Verfahren ferner umfasst: (c) Trocknen des verformten Vlieses, sodass das verformte Vlies einen Wassergehalt von weniger als etwa 12 Gew.-% des verformten Vlieses aufweist.
- 15 15. Verfahren nach einem der vorstehenden Ansprüche, wobei das Vlies eine erste Schicht, umfassend zellulosebasierte Fasern, und eine zweite Schicht umfasst, umfassend thermoplastische Fasern.
16. Verfahren nach Anspruch 1, wobei das Verfahren ferner das Unterziehen eines Fasergewebes einem Verfestigungsverfahren umfasst, um ein Vlies zu erhalten.
17. Verfahren nach Anspruch 16, wobei das Verfestigungsverfahren ein Wasserstrahlverfestigungsverfahren oder ein Nadelfilzverfahren ist.
- 20 18. Verfahren nach Anspruch 16 oder 17, wobei die mechanische Verformung und das Entwässern gleichzeitig ausgeführt werden.

### Revendications

- 25 1. Procédé de production d'un non-tissé déformé comprenant au moins 50 % de fibres à base de cellulose en poids du non-tissé, le procédé comprenant ;
- 30 (a) l'ajustement d'une teneur en eau d'un non-tissé de manière à ce que le non-tissé comprenne au moins une zone ayant une teneur en eau d'au moins 12 % environ en poids du non-tissé dans la zone, et  
(b) la soumission du non-tissé à un procédé de déformation mécanique, le procédé de déformation comprenant la déformation mécanique du non-tissé et la déshydratation du non-tissé pour obtenir un non-tissé déformé ; dans lequel le procédé de déformation comprend un procédé d'ajourage.
- 35 2. Procédé de la revendication 1, dans lequel la déshydratation est effectuée en introduisant de la chaleur dans le non-tissé.
- 40 3. Procédé de la revendication 1, dans lequel la déformation mécanique et la déshydratation sont effectuées simultanément.
- 45 4. Procédé selon l'une quelconque des revendications précédentes, dans lequel les fibres à base de cellulose sont des fibres choisies dans le groupe constitué par les fibres de coton, les fibres de cellulose régénérée et une combinaison de celles-ci.
- 50 5. Procédé selon l'une quelconque des revendications précédentes, dans lequel la déformation mécanique du non-tissé est effectuée par un procédé comprenant :
- (i) la soumission du non-tissé à un appareil de déformation, l'appareil de déformation comprenant un premier élément de formation et un second élément de formation, dans lequel le premier élément de formation comprend des premiers éléments de formation sur sa surface, dans lequel au moins l'un du premier élément de formation et du second élément de formation est chauffé, et  
(ii) le déplacement du non-tissé à travers une ligne de contact formée entre le premier et le second élément de formation, de sorte que des déformations sont formées dans le non-tissé lorsque le premier élément de formation et le second élément de formation sont mis en prise.
- 55 6. Procédé selon la revendication 5, dans lequel l'appareil de déformation comprend une paire de rouleaux.
7. Procédé selon la revendication 5 ou 6, dans lequel le non-tissé est en contact avec le premier et le second élément

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de formation pendant une durée suffisante pour que les déformations se forment et que la déshydratation du non-tissé se produise.

- 5
8. Procédé selon la revendication 1 ou 2, dans lequel la déformation mécanique est effectuée avant la déshydratation.
9. Procédé selon l'une quelconque des revendications précédentes, la chaleur est introduite par une source choisie dans le groupe constitué par un rouleau chauffé, un four, un brûleur, un rayonnement infrarouge et des combinaisons de ceux-ci.
- 10
10. Procédé selon l'une quelconque des revendications précédentes, dans lequel le non-tissé comprend une nappe lacée par filage.
11. Procédé selon l'une quelconque des revendications précédentes, dans lequel la teneur en eau d'un non-tissé est ajustée en appliquant de l'humidité au non-tissé.
- 15
12. Procédé selon l'une quelconque des revendications précédentes, dans lequel la teneur en eau d'un non-tissé est ajustée en appliquant de l'humidité à une zone prédéterminée du non-tissé.
13. Procédé selon l'une quelconque des revendications 1 à 10, dans lequel la teneur en eau d'un non-tissé est ajustée en séchant le non-tissé.
- 20
14. Procédé selon l'une quelconque des revendications précédentes, dans lequel le procédé comprend en outre (c) le séchage du non-tissé déformé, de sorte que le non-tissé déformé présente une teneur en eau inférieure à environ 12 % en poids du non-tissé déformé.
- 25
15. Procédé selon l'une quelconque des revendications précédentes, dans lequel le non-tissé comprend une première couche composée de fibres à base de cellulose et une seconde couche composée de fibres thermoplastiques.
16. Procédé selon la revendication 1, dans lequel le procédé comprend en outre la soumission d'une nappe fibreuse à un procédé d'enchevêtrement pour obtenir un non-tissé.
- 30
17. Procédé selon la revendication 16, dans lequel le procédé d'enchevêtrement est un procédé d'hydro-enchevêtrement ou un procédé d'aiguilletage.
- 35
18. Procédé selon la revendication 16 ou 17, dans lequel la déformation mécanique et la déshydratation sont effectuées simultanément.
- 40
- 45
- 50
- 55

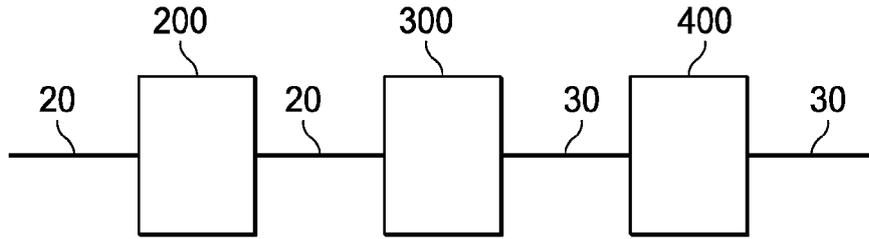


FIG. 1

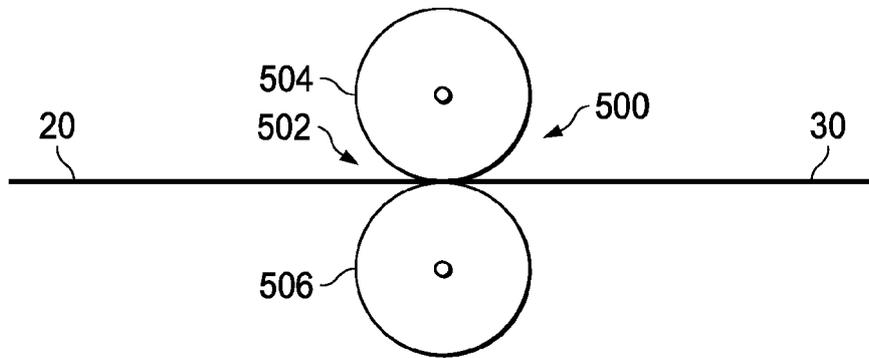


FIG. 2

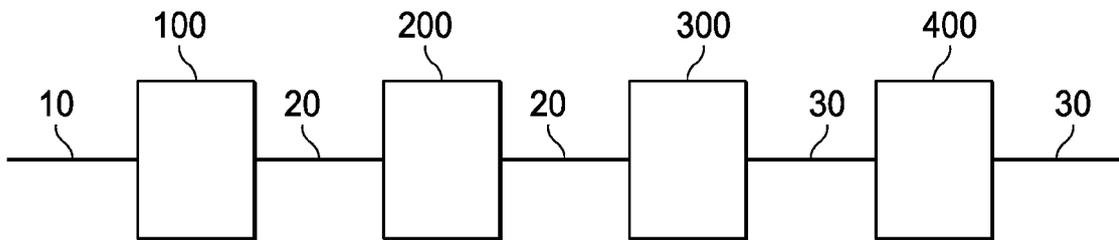


FIG. 3

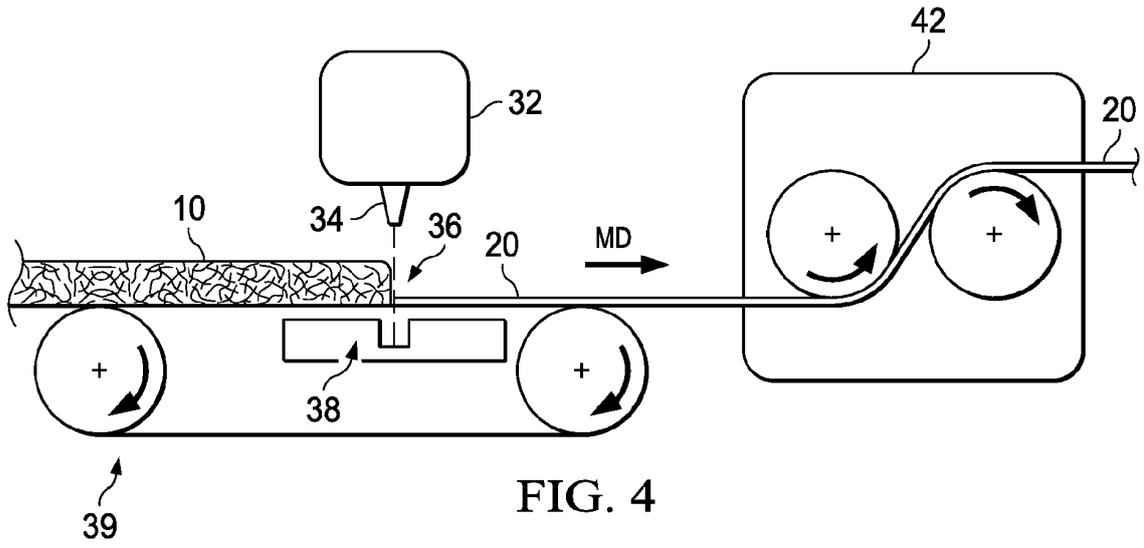


FIG. 4

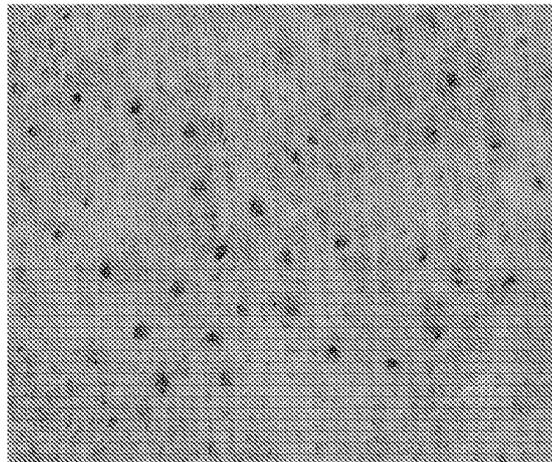


FIG. 5

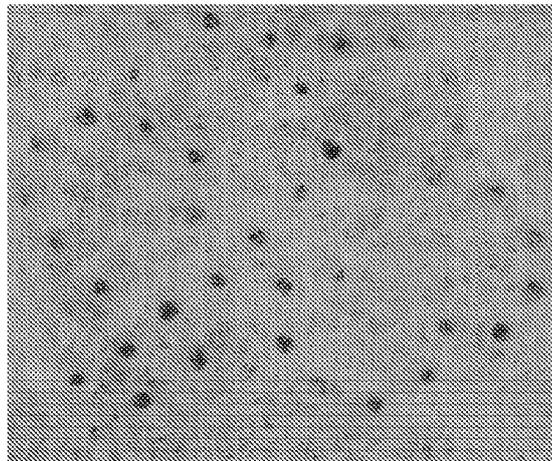


FIG. 6

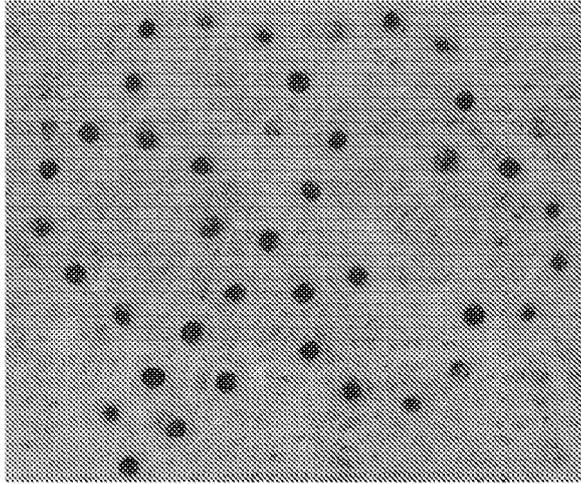


FIG. 7

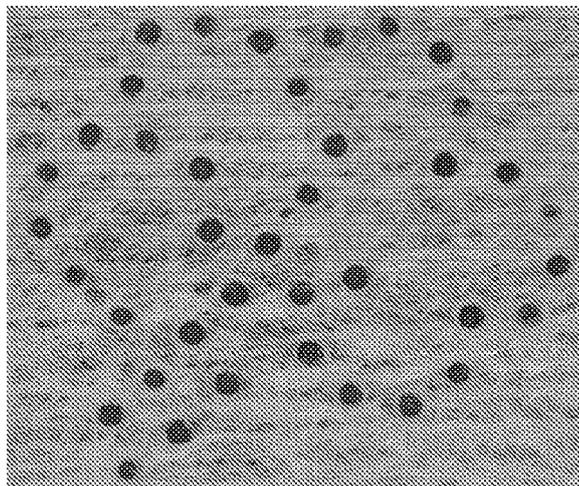


FIG. 8

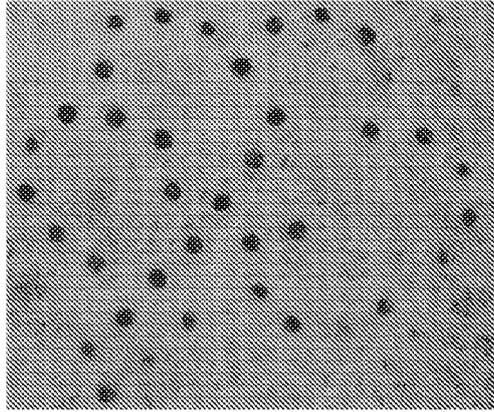


FIG. 9

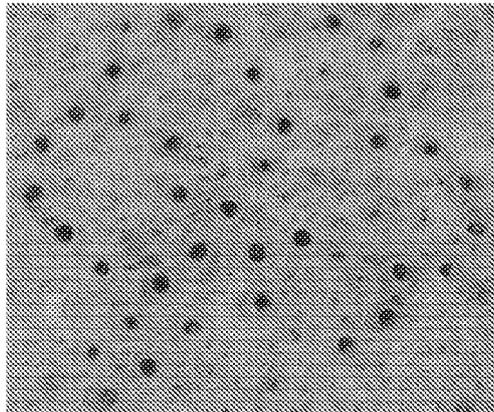


FIG. 10

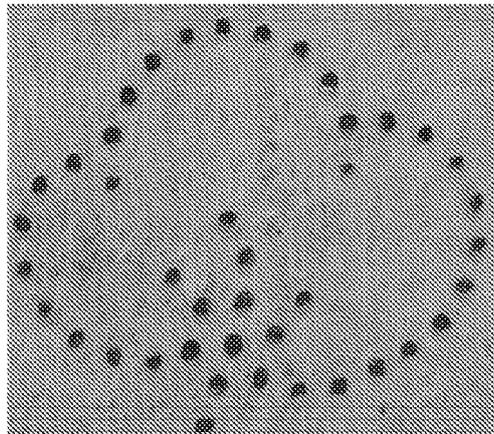


FIG. 11

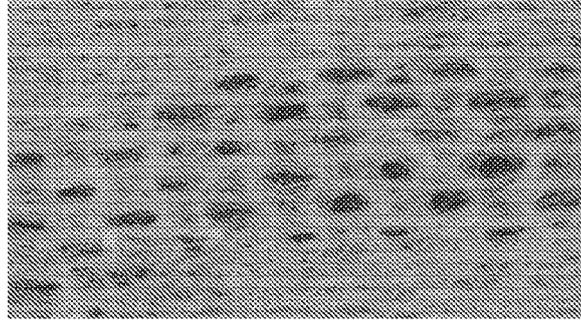


FIG. 12

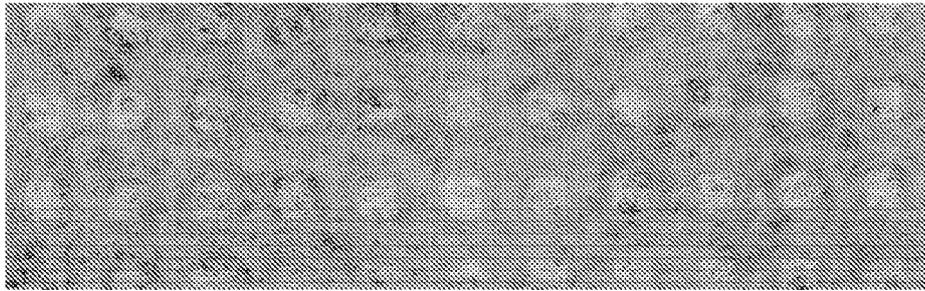


FIG. 13

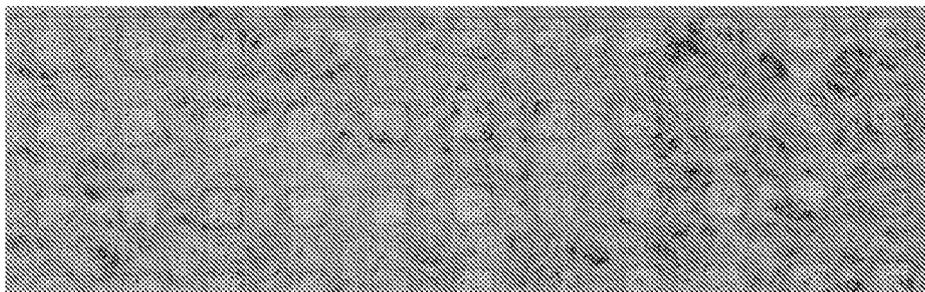


FIG. 14

**REFERENCES CITED IN THE DESCRIPTION**

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