(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 October 2018 (11.10.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/184039 A1

(51) International Patent Classification:
D04H 1/4258 (2012.01) *D04H 3/11* (2012.01)
D04H 1/4374 (2012.01) *C11D 17/04* (2006.01)
D04H 3/013 (2012.01)

(21) International Application Number:
PCT/AT2017/000020

(22) International Filing Date:
03 April 2017 (03.04.2017)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **LENZING AG** [AT/AT]; Werkstrasse 2, A-4860 Lenzing (AT).

(72) Inventors: **CARLYLE, Tom**; 7261 Dellwood Creek Circle, Spanish Fort, Alabama 36527 (US). **EINZMANN, Mirko**; Sandlingstrasse 9, 4600 Wels (AT). **GOLDHALM, Gisela**; Mozartstrasse 2, 3363 Neufurth (AT). **HAYHURST, Malcolm John**; 251 Nuneaton Road, Bulkington, Warwickshire CV12 9RZ (GB). **MAYER, Katharina**; Feldstrasse 39/12, 4813 Altmünster (AT). **SAGERER-FORIC, Ibrahim**; Prinz-Eugen-Strasse 51, 4840 Vöcklabruck (AT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: A NONWOVEN WEB DESIGNED FOR USE AS A DRYER SHEET

(57) Abstract: The present invention describes a nonwoven material for use in a dryer sheet which is compostable and based on renewable resources, comprises essentially pure cellulosic nonwoven web produced as essentially continuous filaments, wherein the essentially continuous filaments in the cellulosic nonwoven web material are multibonded by merged filaments, hydrogen bonding and physical intermingling of the filaments; further the use of a nonwoven material for manufacture of a dryer sheet as well as a dryer sheet containing an according nonwoven material.

WO 2018/184039 A1

A nonwoven web designed for use as a dryer sheet

This invention relates to a nonwoven web suitable to be used as the base sheet for a dryer sheet, and, more particularly, to a 100% cellulose nonwoven web formed from essentially continuous filaments and multibonded by merged filaments, hydrogen bonding and physical intermingling of the filaments, providing the dimensional stability, lotion holding capacity, ability to release said solutions during use, in a sustainable and compostable format. This invention further relates to additional bonding of this web alone, or to other webs or materials through hydroentangling to enhance these key performance properties needed in a dryer sheet.

The term "essentially pure cellulose" shall address the fact that cellulosic moulded bodies, e.g. made according to the lyocell process, always contain a small amount of polymers other than cellulose, namely hemicellulose. This does not influence in any way the suitability for the use according to this invention.

Prior Art

The use of nonwoven material as dryer sheets for use in rotary dryers is well known. In general, dryer sheets include a nonwoven substrate and a chemical composition comprised of at least an anti-static cationic or fabric softening agent and a fragrance. Dryer sheets containing fabric softeners are described by U.S. 3,442,692, U.S. 3,686,025, U.S. 4,834,895; U.S. 5,041,230, and U.S. 5,145,595.

The nonwoven material for dryer sheets has been the subject of much research, as the requirements are stringent and demanding. For example, consumers prefer a soft feel after use when removed from the dryer, and the nonwoven must have a sufficient surface area of the fibrous structure in order to receive and retain the required amount of the chemical composition containing the softening agents and other chemicals. The nonwoven material must be open enough to receive and retain the chemical composition. The nonwoven material must be capable of releasing this chemical composition at a controlled rate during the drying cycle. The nonwoven material should have

a dimensional stability that allows the nonwoven to remain open during the drying cycle so that sufficient contact area for lotion transfer exists. This nonwoven must meet designed thickness requirements, so that the chemical composition may be contained within the nonwoven. Proper packaging of finished dryer sheets also requires a consistent nonwoven thickness. The nonwoven material must also have sufficient tensile strength and elongation, both for manufacturing and coating processes as well as in dryer use.

Many types of nonwovens can be used for dryer sheets, including carded nonwovens, spunlace nonwovens, needlepunch nonwovens, airlaid nonwovens, wetlaid nonwovens and spunlaid nonwovens. All but the last type employ primarily staple or cut fibres, or wood pulp. The last type consists of continuous filaments (either remaining as continuous or cut in the manufacturing process). This nonwoven type, spunlaid nonwovens, has proven to be especially suitable for dryer sheets and is the most widely used nonwoven material for dryer sheets commercially today. Wetlaid paper and/or nonwoven materials are also used commercially.

U.S. 5,470,492 describes a dryer sheet based on spunlaid polyester nonwovens that meets these requirements, having a basis weight of from 0.52 to 0.58 ounces per square yard, comprising fibres with a denier of from about 2 to 6, and a caliper or thickness of about 0.16 mm to about 0.22 mm.

U.S. 5,883,069 adds that the nonwoven substrate based on spunlaid polyester nonwovens for dryer sheets can be improved by increasing the caliper or thickness, as well as increasing its void volume and loft. This is accomplished primarily by using larger denier fibres.

U.S. 5,929,026 teaches further improvements in the nonwoven substrate based on spunlaid polyester nonwovens can be accomplished by increasing the draw in the nonwovens manufacturing process as well as further increasing filament denier size.

Commercially available nonwoven substrates based on spunlaid nonwovens for dryer sheets today use polyester polymer as the primary filament forming material, although other thermoplastic polymers are sometimes used. These are typically neither biodegradable nor compostable.

Wetlaid paper and/or wetlaid nonwovens have been used for dryer sheets. These have significant disadvantages in deteriorating wet strength during the drying cycle, often leaving fibres or lint in with the laundry. This is very undesirable to consumers. Wetlaid nonwovens comprising wood pulp and regenerated cellulose fibres have been developed to address these issues. U.S. 7,947,644 teaches blending wood pulp with rayon or lyocell fibres to increase strength, softness and remain biodegradable and sustainable. These products remain stiff and usually require wet strength additives or chemical binders to produce required strength; these additives and binders introduce undesirable chemicals and cost to the structure.

The present invention relates to the use of specially designed nonwoven materials produced using novel variants of the cellulose spunlaid nonwoven process. The cellulose spunlaid nonwoven process may be also described as a solution blown process and its general principles are known to the expert. The resulting nonwoven web is formed from essentially continuous filaments and multibonded by merged filaments, hydrogen bonding and physical intermingling of the filaments, providing the dimensional stability, lotion holding capacity, ability to release said solutions during use, in a sustainable and compostable format. The lotion is usually made from known chemical antistatic and softening agents and/or fragrances and other additives. There are known methods and products using spunlaid cellulose webs. U.S. 6,358,461, U.S. 7,067,444, U.S. 8,012,565, U.S. 8,191,214, U.S. Pat. No.8,263,506 and U.S. 8,318,318 all teach methods for producing and using spunlaid cellulose webs. None of these teach either production methods for or products addressing the specific requirements for dryer sheets.

Problem

Traditionally, liquid fabric softeners have been used, added into the clothes washer. Liquid fabric softeners are effective in imparting softness and reducing static cling, but they have a number of deficiencies. Liquid fabric softeners are inconvenient to use. They are usually sold in relatively large and heavy containers; liquid fabric softeners must be poured into a small measuring cap or other measuring device to obtain the recommended quantity for a particular size load of wash. The liquid softener must then be poured into a receptacle in the washing machine where it is automatically dosed when the rinse cycle begins. Users find liquid fabric softener easy to spill, both when measuring and pouring it into the washing machine, and then one needs to clean the measuring device, and the spill area, after use.

Another problem with traditional liquid fabric softeners is that all of the articles in the washing machine are subjected to the softening agent. This means that individual softener treatment of articles can only be achieved by washing them separately. This is inefficient and requires the use of additional energy and water.

Liquid fabric softeners are also known to have an adverse effect on the flammability of clothing items.

With respect to "dry dryer sheets," they are generally sheets of non-woven material impregnated with a chemical composition usually consisting of a cationic softening agent, antistatic agents, dispersing agents and a fragrance. The nonwoven sheet, or web, is typically a 100% thermoplastic substrate, or a paper-based substrate. The softening, or other fabric treating, agent is applied to the non-woven material either in a wet state and then dried in an oven, or applied in a very low moisture content viscose solution, so that it is mostly "dry" when packaged, and provided to the consumer ready for use. One, or more, dry dryer sheets are placed into the clothes dryer with the freshly laundered, damp items of clothing. The lotion on the dryer sheet of nonwoven material is released over the course of the drying cycle as the chemical

composition is softened as the heat is induced within the drying process. Additionally, contact with the clothing induced by the tumbling action of the dryer helps with the application of the chemical composition to the clothing articles.

Although much more convenient to use than liquid fabric softeners, the dry dryer sheets described above also have a number of limitations, which are created by the type of nonwoven sheet that is used. One of the limitations of dry dryer sheets which use a 100% thermoplastic substrate is that a relatively high temperature is required in order to activate the softening or other fabric treating agent on the non-woven sheet and release it into the fabric of the clothing. Most clothes dryers have several heat settings to accommodate different types of clothing. For example, delicate fabrics are preferably dried at lower heat settings and temperatures than clothing made from rayon, cotton or the like. At lower heat settings, dry dryer sheets using 100% thermoplastic substrates are of marginal effectiveness and therefore delicate fabrics or other clothing dried at lower temperatures are not treated as effectively with this type of dry dryer sheet product, and will not exhibit the desired softness and feel when they are worn. This is a pervasive problem in many countries, where high energy cost can necessitate operating clothes dryers at lower temperatures. Additionally, it is commonly seen that clothing dried at high heat settings and temperatures will have a higher probability of static cling and wrinkling. This is often seen even when the dry dryer sheet is provided with anti-static agents. Furthermore, high drying temperatures are known to be hard on fabrics, tending to break them down over time. Another limitation of 100% thermoplastic substrates is that most are neither biodegradable nor compostable.

One of the limitations of dry dryer sheets which use a paper-based substrate is a decreasing wet strength during use. These paper-based dry dryer sheets will quickly absorb some of the dampness from articles that are placed in the rotary dryer. The increased moisture content in the dryer sheet will decrease the wet strength of the nonwoven paper-based substrate, this in combination

with the tumbling action of the dryer and the friction between the different fabrics that are being treated and the dryer sheet can cause the dryer sheet substrate to break apart. This will result in small pieces of the paper-based substrate becoming trapped with the clothes and will require that the dryer is cleaned after use to remove all of the small pieces of debris. Additionally, the paper-based substrates do not have a good dimensional stability such that they will remain mostly open, and not fold in on itself, when it is wet and undergoes tumbling in the dryer. This results in a very low surface area and limits the contact with clothes, and the transfer of the impregnated chemicals.

Description

It is an object of the present invention to provide a nonwoven material for use in a dryer sheet which is compostable and based on renewable resources, comprising essentially pure cellulosic nonwoven web produced as essentially continuous filaments, and can be loaded with and is capable of releasing fabric softening agents and other chemicals in desired amounts across the full range of temperatures used in a rotary clothes dryer, and is not negatively impacted by contact with moisture in the dryer wherein the essentially continuous filaments in the cellulosic nonwoven material are multibonded by merged filaments, hydrogen bonding and physical intermingling of the filaments

This nonwoven material will provide better functionality across a wider range of clothes drying conditions.

Due to its absorbent character, this nonwoven material will allow application of the chemical composition to begin sooner and to be more efficient at lower drying temperatures. Water from the wet laundry is absorbed by the nonwoven material allowing for faster heat transfer from the dryer air to the nonwoven material thereby allowing the lotion to begin softening at a lower temperature, in addition to working well at higher drying temperatures. The merged filament bonding provides a nonwoven web that is very dimensionally stable (even when wet), which allows the dryer sheet to be more fully utilized during the drying process.

In a preferred embodiment of the invention the cellulosic nonwoven web is made according to a lyocell process. Fibers and filaments derived from a lyocell process are known to wick moisture through the internal fiber structure. This allows for faster wicking of moisture from the wet laundry, enabling the lotion to begin softening at lower dryer temperatures.

Cellulosic fibres can be produced by various processes. In one embodiment a lyocell fibre is spun from cellulose dissolved in N-methyl morpholine N-oxide (NMMO) by a meltblown process, in principle known from e.g. EP 1093536 B1, EP 2013390 B1 and EP 2212456 B1. Where the term meltblown is used it will be understood that it refers to a process that is similar or analogous to the process used for the production of synthetic thermoplastic fibres (filaments are extruded under pressure through nozzles and stretched to required degree by high velocity/high temperature extension air flowing substantially parallel to the filament direction), even though the cellulose is dissolved in solution (i.e. not a molten thermoplastic) and the spinning & air temperatures are only moderately elevated. Therefore the term "solution blown" may be even more appropriate here instead of the term "meltblown" which has already become somewhat common for these kinds of technologies. For the purposes of the present invention both terms can be used synonymously. In another embodiment the web is formed by a spun bonding process, where filaments are stretched via lower temperature air. In general, spunbonded synthetic fibres are longer than meltblown synthetic fibres which usually come in discrete shorter lengths. Fibres formed by the solution blown lyocell process can be continuous or discontinuous depending on process conditions such as extension air velocity, air pressure, air temperature, viscosity of the solution, cellulose molecular weight and distribution and combinations thereof.

In one embodiment for making a nonwoven web the fibres are contacted with a non-solvent such as water (or water/NMMO mixture) by spraying, after extrusion but before web formation. The fibres are subsequently taken up on a moving foraminous support to form a nonwoven web, washed and dried.

Freshly-extruded lyocell solution ('solvent spun', which will contain only, for example, 5-15% cellulose) behaves in a similar way to 'sticky' and deformable

thermoplastic filaments. Causing the freshly-spun filaments to contact each other while still swollen with solvent and with a 'sticky' surface under even low pressure will cause merged filament bonding, where molecules from one filament mix irreversibly with molecules from a different filament. Once the solvent is removed and coagulation of filaments completed, this type of bonding is impossible.

It is another object of the present invention to provide a process for the manufacture of a nonwoven material consisting of essentially continuous cellulosic filaments by:

a. Preparation of a cellulose-containing spinning solution

b. Extrusion of the spinning solution through at least one spinneret containing closely-spaced meltblown jet nozzles

c. Attenuation of the extruded spinning solution using high velocity air streams,

d. Forming of the web onto a moving surface [e.g. a perforated belt or drum],

e. Washing of the formed web

f. Drying of the washed web

wherein in step c. and/or d. coagulation liquor, i.e. a liquid which is able to cause coagulation of the dissolved cellulose; in a lyocell process this preferably is water or a diluted solution of NMMO in water, is applied to control the merged filament bonding. The amount of merged filament bonding is directly dependent on the stage of coagulation of the filaments when the filaments come into contact. The earlier in the coagulation process that the filaments come into contact, the greater the degree of filament merging that is possible. Both placement of the coagulation liquor application and the speed at which the application liquor is applied can either increase, or decrease, the rate of coagulation. Which results in control of the degree (or amount) of merged filament bonding that occurs in the material.

Preferably the merged filament bonding is further controlled by filament spinning nozzle design and arrangement and the configuration and temperature of filament extension air. The degree of molecular alignment that is present as the solution exits the spinning nozzle has an impact on the

coagulation rate. The more aligned the molecules are, the faster the coagulation rate, and conversely, the less aligned the molecules are, the slower the coagulation rate. The spinning nozzle design and arrangement, along with the molecular weight of the cellulosic raw material used will determine the starting coagulation rate at the exit of the spinning nozzle. Additionally, the rate of cooling (temperature decrease) of the solution upon spinning nozzle exit will impact the coagulation rate as well. The slower the cooling rate, the slower the coagulation rate, and conversely, the faster the cooling rate, the faster the coagulation rate. Therefore, configuration of the filament extension air can directing impact the cooling rate and therefore, impact the coagulation rate, which impacts the achievable amount of merged filament bonding that is possible.

In a preferred embodiment of the process according to the invention at least two spinnerets (also known as jets), preferably between two and ten, and further preferred between 2 and 6, each one arranged to form a layer of nonwoven web, are used to obtain a multilayer nonwoven material. By applying different process conditions at the individual spinnerets it is even possible to obtain a multilayer nonwoven material wherein the individual layers have different properties. This may be useful to optimize the nonwoven material according to the invention for different applications. In one embodiment this could provide a gradient of filament diameters from one side of the material to the other side by having each individual web having a standard filament diameter that is less than the web on top, it is possible to create a material suitable for use as an air filter media that will provide a gradient of pore size (particle size capture). This will provide an efficient filtration process and result in a lower pressure drop across the filter media compared to a single web with similar characteristics at the same basis weight and pore size distribution.

Preferably the filaments are spun using a solution of cellulose in an aqueous amine oxide and the coagulation liquor is water, preferably with a content of amine oxide not being able to dissolve cellulose, also referred to as a lyocell process; the manufacture of such a solution is in principle known, e.g. from

U.S. 6,358,461, U.S. 7,067,444, U.S. 8,012,565, U.S. 8,191,214, U.S. Pat. No.8,263,506 and U.S. 8,318,318; preferably the amine oxide is NMMO.

The present invention describes a cellulosic nonwoven web produced via a meltblown or spunbond-type process. The filaments produced are subjected to touching and/or compaction and/or intermingling at various points in the process, particularly before and during initial web formation. Contact between filaments where a high proportion of solvent is still present and the filaments are still swollen with said solvent causes merged filament bonding to occur. The amount of solvent present as well as temperature and contact pressure (for example resulting from extension air) controls the amount of this bonding.

In particular the amount of filament intermingling and hydrogen bonding can be limited by the degree of merged filament bonding. This is the result of a decrease in filament surface area and a decrease in the degree of flexibility of the filaments. For instance, as the degree of merged filament bonding increase, the amount of overall surface area is decreased, and the ability of cellulose to form hydrogen bonds is directly dependent on the amount of hydroxyl groups present on the cellulosic surface. Additionally, filament intermingling happens as the filaments contact the forming belt. The filaments are traveling at a faster rate of speed than the forming belt. Therefore, as the filament contacts the belt, it will buckle and sway side to side, and back and forth, just above the forming belt. During this buckling and swaying, the filaments will intermingle with neighboring filaments. If the filaments touch and merge prior to the forming belt, this limits the number of neighboring filaments by which it can intermingle with. Additionally, filaments that merge prior to contacting the forming belt with not have the same degree of flexibility as a single filament and this will limit the total area over which the filament will buckle and sway.

Surprisingly, it has been found that high levels of control of filament merging can be achieved by modifying key process variables. In addition, physical intermingling of at least partially coagulated cellulose filaments can occur after initial contact with non-solvent, particularly at initial filament laydown to form the web. It arises from the potential of the essentially continuous filaments to

move laterally during initial filament formation and initial laydown. Degree of physical intermingling is influenced by process conditions such as residual extension air velocity at the foraminous support (forming belt). It is completely different from the intermingling used in production of webs derived from cellulose staple fibers. For staple fibers, an additional process step such as calendaring is applied after the web has been formed. Filaments which still contain some residual solvent are weak, tender and prone to damage. Therefore, in combination with controlling degree and type of bonding at this stage, it is essential that process conditions are not of a type which could cause filament and web damage. Initial drying of the washed but never-dried nonwoven, together with optionally compacting, will cause additional hydrogen bonding between filaments to develop. Modifying temperature, compacting pressure or moisture levels can control the degree of this hydrogen bonding. Such treatment has no effect on intermingling or the merged filament bonding.

In a preferred embodiment of the invention the nonwoven material is dried prior to subsequent bonding/treatment.

In a preferred embodiment of the invention the percentage of each type of bonding is controlled using a process with up to two compaction steps, where one of these compaction steps is done after step d. of the inventive process where the spun filaments are still swollen with a solvent, and one of these compaction steps is done before or in step e. of the inventive process where all or most of the solvent has been removed and the web has been wet with water. As previously discussed, control of the coagulation of the spun solution is a factor in controlling the degree of merged filament bonding. This preferred embodiment concerns decreasing the coagulation rate to a state where additional compaction steps can be used after filament laydown to further increase the actual amount of merged filament boding that is achievable. It might be helpful to view the maximum achievable filament bonding as the state where we have merged all filaments into an essentially film-like structure.

The present invention describes a process and product where merged filament bonding, physical intermingling and hydrogen bonding can be controlled independently. However, the degree of merged filament bonding can limit the degree of physical intermingling and hydrogen bonding that can occur. In addition, for the production of multi-layer web products, process conditions can be adjusted to optimise these bonding mechanisms between layers. This can include modifying ease of delamination of layers, if required.

In addition to merged filament, intermingling and hydrogen bonding being independently set as described above, additional bonding/treatment steps may optionally be added. These bonding/treatment steps may occur while the web is still wet with water, or dried (either fully or partially). These bonding/treatment steps may add additional bonding and/or other web property modification. These other bonding/treatment steps include hydroentangling or spunlacing, needling or needlepunching, adhesive or chemically bonding. As will be familiar to those skilled in the art, various post-treatments to the web may also be applied to achieve specific product performance. By contrast, when post-treatments are not required, it is possible to apply finishes and other chemical treatments directly to the web of this invention during production which will not then be removed, as occurs with, for example, a post-treatment hydroentanglement step.

Varying the degree of merged filament bonding provides unique property characteristics for nonwoven cellulose webs with regards to softness, stiffness, dimensional stability and various other properties. Properties may also be modified by altering the degree of physical intermingling before and during initial web formation. It is also possible to influence hydrogen bonding, but the desired effect of this on web properties is minor. Additionally, properties can be adjusted further by including an additional bonding/treatment step such as hydroentangling, needlepunching, adhesive bonding and/or chemical bonding. Each type of bonding/treatment provides benefits to the nonwoven web. For example, hydroentangling can add some strength and soften the web as well as potentially modifying bulk density; needling is typically employed for higher basis weights and used to provide

additional strength; adhesive and chemical bonding can add both strength and surface treatments, like abrasive material, tackifiers, or even surface lubricants.

The present invention allows independent control of the key web bonding features: merged filaments, intermingling at web formation, hydrogen bonding and optional additional downstream processing. Manipulation of merged filament bonding can be varied to predominantly dictate the properties of the nonwoven web.

In a further preferred embodiment of the invention the nonwoven cellulosic web is hydroentangled. Hydroentangling is known by those skilled in the art: to provide strength to a fibrous nonwoven material, to provide some softening of the nonwoven material and/or to modify the thickness of the nonwoven material. Modification of these properties can be made such that a positive impact on the nonwoven material performance as a dryer sheet is seen. For instance, increased thickness allows the nonwoven material to hold more lotion at a given basis weight. It can also provide faster heat transfer because of increased air permeability, allowing the softening of the lotion to begin sooner in the dryer process.

Preferably the basis weight, i.e. without agents and other chemicals, of the nonwoven web according to the invention is from 10 grams/square meter to 25 grams/square meter. This basis weight range allows for a good balance between lotion absorption capacity and air permeability.

In a further preferred embodiment of the invention the cellulosic nonwoven material consists of multiple layers. Preferably the multiple layers are bonded together using merged filament bonding, hydrogen bonding and filament intermingling of the filaments of the different layers.

In a further preferred embodiment the resulting multi-layered nonwoven material is further processed by using one or more out of the group of techniques consisting of hydroentangling, spunlacing, needling, needlepunching, adhesive and chemical bonding. These processes are

known to provide adjusts to nonwoven material physical properties at a given basis weight that can provide enhanced performance attributes of the nonwoven material.

The layers of the nonwoven material are bonded together in such a manner that the dryer sheet can be delaminated into single sheets during use as a dryer sheet. Delamination of the nonwoven layers can occur due to moisture absorption, heat and friction from tumbling action with the laundry. The resulting effect is a complete separation of the layers, creating more surface contact area and thereby, more efficient active ingredient transfer to the laundry.

A further object of the invention is the use of a nonwoven material according to the invention as described above for manufacture of a dryer sheet.

A further object of the invention is a dryer sheet containing a nonwoven material according to the invention as described above.

The invention will now be illustrated by examples. These examples are not limiting the scope of the invention in any way. The invention includes also any other embodiments which are based on the same inventive concept

Examples

All samples discussed below were conditioned at 23°C (±2°C) and 50% (±5%) relative humidity for 24 hours.

Example 1

A 20 gsm product of invention was characterized for its potential to take up lotion for use as a dryer sheet. This was done by measuring oil absorbency capacity against two commercial dryer sheet products, both were spunbond polyester and also being 20 gsm in basis weight

The test was performed according to EDANA NWSP 010.4.R0 (15) - Evaluation of Oil and Fatty Liquids Absorption" using motor oil of the type SAE 10W-40 with the following modification: to improve consistency of evaluation,

the conditioned specimen was hung prior to test from a ruler using threads (see Figure 1). With this support it was possible to still submerge the specimen fixed to threads (ruler stayed outside oil vessel) and easily remove the specimen from the oil without wrapping up in itself. After removing the specimen from the oil it was very easy with this support to hang the specimen according to the EDANA method for the defined drip off time.

The liquid absorptive capacity (LAC) in % of each specimen was calculated as follows:

$$LAC = (M_n - M_k)/M_k \times 100$$

M_k: initial mass in g of the conditioned test specimen

M_n: mass in g of the wet test specimen at the end of the test

The product of invention showed 1.6 - fold higher oil absorbency than the commercial products. This indicates that the product of invention has the capability of taking up high amounts of dryer sheet lotion during the converting process – as these very often contain lipophilic substances.

Example 2

The product of invention of example 1 was further investigated for its dry lint during tumble drying of black laundry. For this, a 'worst case conditions scenario' was chosen, with the product of invention being tested in the raw state without containing any lotion (which would decrease friction between the dryer sheet and the laundry). Tumble drying was performed at 85°C for 30 minutes. The dryer used was an Electrolux T3190. The laundry consisted of 2 kg (dry weight) of wet black knitted clothing. The product of invention released no visible lint to laundry during this test.

Example 3

A 25 gsm product of the invention was compared to a fully cellulosic staple fiber carded-hydroentangled dryer sheet, also being of 25 gsm, in terms of stiffness.

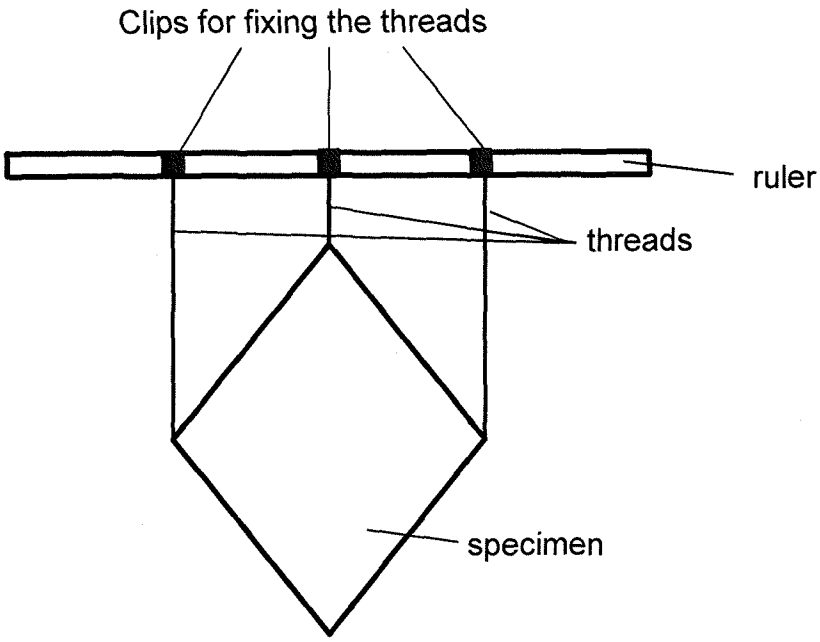
Stiffness was measured using a 'Handle-o-meter', according to standard method WSP 90.3, with ¼ inch slot width, stainless steel surface, 1000 g beam. Sample size was to 10 x 10 cm.

The product of the invention exhibited a 2.5 times higher overall stiffness compared to the competitive product, meaning that it has the possibility to maintain a more open structure during tumble drying.

Claims

1. A nonwoven material for use in a dryer sheet which is compostable and based on renewable resources, comprises essentially pure cellulosic nonwoven web produced as essentially continuous filaments, characterized in that the essentially continuous filaments in the cellulosic nonwoven web material are multibonded by merged filaments, hydrogen bonding and physical intermingling of the filaments.
2. The nonwoven material of Claim 1 where the cellulosic nonwoven web is made according to a lyocell process.
3. The nonwoven material of Claim 1 where the nonwoven cellulosic web is hydroentangled.
4. The nonwoven material of Claim 1 where the basis weight of the nonwoven web is from 10 grams/square meter to 25 grams/square meter.
5. The nonwoven material of claim 1, where the cellulosic nonwoven web consists of multiple layers.
6. The nonwoven material of claim 5, where the multiple layers are bonded together using merged filament bonding, hydrogen bonding and filament intermingling of the filaments of the different layers.
7. The nonwoven material of Claim 5, where the resulting multi-layered nonwoven material is further processed by using one or more out of the group of techniques consisting of hydroentangling, spunlacing, needling, needlepunching, adhesive and chemical bonding.
8. The nonwoven material of claim 5 wherein the layers are bonded together in such a manner that the dryer sheet can be delaminated into single sheets during use as a dryer sheet.
9. The use of a nonwoven material according to claim 1 for manufacture of a dryer sheet.
10. A dryer sheet containing a nonwoven material according to claim 1.

Fig. 1: Specimen hanger assembly



INTERNATIONAL SEARCH REPORT

International application No
PCT/AT2017/000020

A. CLASSIFICATION OF SUBJECT MATTER
INV. D04H1/4258 D04H1/4374 D04H3/013 D04H3/11 C11D17/04
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D04H C11D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/124521 A1 (CHEMIEFASER LENZING AG [AT]; WHITE PAT [GB]; HARMS HAIO [AT]; HAYHURST) 8 November 2007 (2007-11-08) claims 1, 14, 19-20 page 1, line 26 - line 28 page 2, line 10 - page 3, line 6 page 3, line 20 - line 23 page 7, line 14 page 6, line 8 - line 21 page 7, line 23 - line 25 -----	1-8
X	US 2010/162542 A1 (LUO MENGKUI [US] ET AL) 1 July 2010 (2010-07-01) paragraphs [0020], [0021], [0023] paragraphs [0033] - [0037] table 2A paragraphs [0049] - [0050] -----	1-5,8

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 October 2017	06/11/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Beckert, Audrey

1

INTERNATIONAL SEARCH REPORT

International application No
PCT/AT2017/000020

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/324926 A1 (LUO MENGKUI [US]) 31 December 2009 (2009-12-31) paragraphs [0017] - [0019] paragraph [0021] table 3 paragraph [0033]	1-5,8
X	WO 2009/105490 A1 (SELLARS ABSORBENT MATERIALS INC [US]; SELLARS WILLIAM R [US]) 27 August 2009 (2009-08-27) figures 1, 2A paragraphs [0013], [0024] - [0026]	1-8
A	US 2003/188450 A1 (OGDEN J MICHAEL [US] ET AL) 9 October 2003 (2003-10-09) claim 1 paragraphs [0025], [0031]	9,10
A	US 2008/076695 A1 (UITENBROEK DAVID [US] ET AL) 27 March 2008 (2008-03-27) paragraph [0045]; claim 1 paragraphs [0026] - [0028]	9,10

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/AT2017/000020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007124521 A1	08-11-2007	AT 503625 A1	15-11-2007
		CN 101432476 A	13-05-2009
		CN 103173938 A	26-06-2013
		EP 2013390 A1	14-01-2009
		EP 2957667 A1	23-12-2015
		ES 2553182 T3	04-12-2015
		JP 5097771 B2	12-12-2012
		JP 2009535521 A	01-10-2009
		KR 20080111521 A	23-12-2008
		US 2009186189 A1	23-07-2009
		WO 2007124521 A1	08-11-2007
US 2010162542 A1	01-07-2010	NONE	
US 2009324926 A1	31-12-2009	NONE	
WO 2009105490 A1	27-08-2009	EP 2244876 A1	03-11-2010
		US 2011045261 A1	24-02-2011
		WO 2009105490 A1	27-08-2009
US 2003188450 A1	09-10-2003	AU 2003218469 A1	27-10-2003
		US 2003188450 A1	09-10-2003
		US 2005020475 A1	27-01-2005
		WO 03087465 A1	23-10-2003
US 2008076695 A1	27-03-2008	NONE	