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(54) **ANTI-PILLING LAUNDRY SHEET**

(57) The present application discloses an anti-pilling laundry sheet and a method of preparing a respective sheet with high speed and at the same time high accuracy.

EP 3 412 761 A1

Description

[0001] The present application discloses an anti-pilling laundry sheet and a method of preparing a respective sheet with high speed and at the same time high accuracy.

[0002] It is known that textiles age with time. Colored textiles appear paler with the time if the color fades during washing. Especially cotton-based garments additionally age with the appearance of fuzz on the surface. This fuzz (or fuzz-balls) itself reduces the attractivity of the appearance of the textiles. At the same time, the color intensity of colored textiles is reduced due to this fuzzing resulting in a pale appearance of the clothes.

[0003] To keep the fresh and new, colorful appearance of textiles as long as possible, different additives are used in usual detergents, such as UV-protection, preventing paling of colors due to UV-light, or additives for color refreshing.

[0004] During washing, dyes of clothes are released from garments. To prevent the re-deposition of released dyes on cloth, laundry aids in the form of sheets are described in the prior art, for example in EP 2 835 419 A1, WO 2007/088149 A1 or PCT/EP2017/050080.

[0005] Whereas known sheets deal with color catching, there is still a need for the consumer to also reduce the fuzzing of fibers on the substrate, especially on cotton-based textiles. Surprisingly, it has been found that cellulase on a water-insoluble substrate is able not only to reduce the appearance of fuzz, but also can remove already existing fuzz from the garment. Thus, the present application refers to a sheet with anti-pilling properties meaning that the sheet is able to remove fuzz from textiles, especially cotton-based textiles.

[0006] In a first aspect, the present application therefore refers to a method of preparing a laundry sheet with anti-pilling properties comprising:

(i) providing a water insoluble substrate,
(ii) providing at least one aqueous solution comprising from 0.01 % by weight to 4 % by weight, preferably 0.25 % by weight to 1.8 % by weight, especially from 0.4 % by weight to 1 % by weight, based on the total weight of the solution, of active cellulase enzyme protein,
(iii) applying the aqueous solution onto the substrate with a flexographic printing machine such that the amount of the aqueous solution on the substrate after the coating is within a range from 1 gsm to 10 gsm, preferably from 1.5 gsm or 1.8 gsm to 5 gsm or 8 gsm, especially from 2 gsm to 3 gsm.

[0007] Preferably, the aqueous solution comprises

(a) from 40 % by weight to 95 % by weight, preferably 60 % by weight to 90 % by weight, especially from 75 % by weight to 85 % by weight, of water and
(b) from 0.01 % by weight to 4 % by weight, preferably 0.25 % by weight to 1.8 % by weight, especially from 0.4 % by weight to 1% by weight, active cellulase enzyme protein,

based on the total weight of the solution.

[0008] Amounts in percentage mentioned in the present application are "percent by weight", if not explicitly indicated otherwise. If amounts of weight are indicated for the aqueous solution, they refer to the total weight of the aqueous solution, which always amounts to 100 % by weight. If the "percent by weight" refer to any other composition, it is also based on the total amount of the composition, which amounts to 100 % by weight.

[0009] The method according to the present invention uses flexographic printing in a flexographic printing machine for providing a cellulase coated substrate. Flexographic printing is a specific printing method, which enables the application of the aqueous solution with high speed but at the same time high accuracy. For the first time, the present application describes flexographic printing of textile sheets with an aqueous cellulase solution.

[0010] Flexographic printing enables that the amount of the aqueous solution comprising cellulase on the substrate after the coating can be controlled with high accuracy, so that it can be ensured that the amount is within a range of from 1 gsm (gram per square meter, which means 1 gram of the aqueous solution comprising cellulase per square meter of the substrate) to 10 gsm. The amount is preferably within a range from 1.5 gsm to 8 gsm, especially from 1.8 gsm to 5 gsm, especially preferred from 2 gsm to 3 gsm. The amount of 1 gsm is necessary to reduce the number of fuzz on textiles during laundry, especially cotton-based textiles.

[0011] The amount from 1.8 gsm to 5 gsm of a solution with an amount of from 0.4 % per weight to 1 % per weight of active cellulase enzyme protein applied onto the substrate is especially preferred, as this is sufficient to enable the removal of fuzz from garments and thus providing an anti-pilling laundry sheet for the use in a household washing machine. This corresponds to an especially preferred amount of active cellulase enzyme protein of from 0.0072 gsm or 0.012 gsm to 0.018 gsm or 0.03 gsm, for example 0.02 gsm, 0.023 gsm, or 0.025 gsm. At the same time, no unwanted side-effects such as a weakening of the fabric to be treated with the sheet, occurs. Especially if the sheet is used regularly, the anti-pilling effect will be visible and the amount of fuzz will be significantly reduced if the amount of active enzyme

is as indicated above.

[0012] The fabric to be treated with the anti-pilling laundry sheet according to the present invention might become weak if the resulting wash liquor contains a high concentration of active cellulase enzyme protein. This unwanted side effect might especially occur if the fabric is treated in this way regularly.

[0013] Cellulase is an enzyme that catalyses cellulolysis, the decomposition of cellulose and of some related polysaccharides. Thus, a cellulase is an enzyme, catalyzing the hydrolysis of 1,4-β-D-glycosidic linkages in cellulose (cellobiose) and/or hemicellulose, and/or lichenin, and/or cereal β-D-glucans. They are often able to specifically hydrolyse the 1,4-linkage in β-D-glucanes, which comprise beside said 1,4-linkage also a 1,3-linkage.

[0014] Within the numerical classification system for enzymes (E.C.-classification, "Enzyme Classification" number), cellulase has the EC-number 3.2.1.4, meaning they are hydrolases (E.C. 3.-.-.-) with the subgroup of glycosylases (E.C. 3.2.-.-) and again the subgroup of glycosidases (E.C. 3.2.1.-). Thus, cellulases are able to hydrolyze O- and/or S-glycosylic-linkages.

[0015] Several different kinds of cellulases are known, which differ structurally and mechanistically. Synonyms, derivatives and specific enzymes associated with the name "cellulase" and which are also enclosed by said term within the meaning of the present invention include endo-1,4-β-D-glucanase (β-1,4-glucanase, β-1,4-endolgucan hydrolase, endoglucanase D, 1,4-(1,3,1,4)-β-D-glucan 4-glucanohydrolase), carboxymethyl cellulase, avicelase, celludextrinase, cellulase A, cellulosin AP, alkali cellulase, cellulase A 3, 9.5 cellulase, and pancellase SS. As soon as an enzyme is able to hydrolyse 1,4-β-D-glycosidic linkages, it is a cellulase within the meaning of the present invention.

[0016] Suitable cellulases (endoglucanases, EG) are, for example, the EG-rich cellulase, expressed by fungi, composition, as well as their development, being sold by Novozymes company under the trade name Celluzyme®. Other suitable cellulase compositions from Novozymes are sold under the tradename Endolase® and Carezyme® based on the 50kD-EG and the 43 kD-EG respectively from Humicola insolens DSM 1800. Further products sold by Novozymes which might be used within the meaning of the present invention are sold under the trade name Cellusoft®, Renozyme® and Celluclean®.

[0017] Also the company AB Enzymes, Finland, sells suitable cellulase compositions, which are sold under the trade name Ecostone® and Biotouch®, which are at least partly based on 20 kD-EG of melanocarpus. Further cellulases of AB Enzymes are Econase® and Ecopulp®. Further suitable cellulases are of Bacillus sp. CBS 670.93 and CBS 669.93, whereas the cellulase of Bacillus sp. CBS 670.93 are sold under the trade name Puradax® by the company Danisco/Genencor. Further commercial available products of Danisco/Genencor are "Genencor detergent cellulase L" and IndiAge®Neutra.

[0018] Variations of these enzymes obtainable by point-mutation can also be used according to the present invention. Especially preferred cellulases are variations of thielavia terrestris cellulases, which are disclosed in WO 98/12307, cellulase of melanocarpus, especially melanocarpus albomyces, disclosed in WO 97/14804, cellulases of EGIII-type of trichoderma reesei, as published in EP 1 305 432 and variations of those, especially such variations disclosed in EP 1 240 525 and EP 1 305 432, as well as cellulases disclosed in WO 1992/006165, WO 96/29397 and WO 02/099091. The content of the above mentioned publications and especially the cellulases disclosed therein are enclosed in their entirety explicitly also in this present application.

[0019] The aqueous solution preferably comprises from 40 % by weight to 95 % by weight of water and from 0.01 % by weight to 4 % by weight of active cellulase enzyme protein. The total amount of aqueous solution amounts to 100 % by weight. The amount of water is preferably in a range from 60 % by weight to 90 % by weight, especially from 75 % by weight to 85 % by weight; the amount of water representing the total amount of water which might also occur from any additional components of the aqueous solution. The amount of active cellulase enzyme protein in the aqueous solution is preferably in a range from 0.25 % by weight or more, especially 0.4 % by weight or more, and preferably 1.8% by weight or less, especially 1 % by weight or less.

[0020] The aqueous solution according to the present application is a water-based cellulase solution, which might further comprise one or more of a binder, an antifoaming agent, a surfactant, a colorant and/or a perfume. The colorant can be any suitable colorant but is preferably a pigment to prevent staining of textiles during washing by the anti-pilling sheet itself.

[0021] Thus, the aqueous solution according to the present invention might comprise, e.g., water and cellulase and a binder, or water and cellulase and a binder and an antifoaming agent, or water and cellulase and a binder and an antifoaming agent and a colorant. In one preferred embodiment, the aqueous solution comprises not only water and cellulase but also a colorant.

[0022] The aqueous solution might further comprise a binder and/or an antifoaming agent. The antifoaming agent helps in the production and processing of the aqueous solution. It can be any antifoaming agent known for detergents. Suitable antifoaming agents, known from the prior art, are preferably selected from siloxanes or silicones or mixtures of those. Siloxanes might also be describes as silicone oils, which are organo-polysiloxanes, being liquid at room temperature. These silicone oils might also comprise silicic acid. Their Brookfield viscosity at 25 °C is preferably within a range from 5000 mPas to 50000 mPas, especially from 10000 mPas to 30000 mPas. Especially preferred siloxanes comprise

an almost linear diorgano siloxane polymer chain or diorgano siloxane copolymer chain. The organic residues bound to the silicon atoms preferably are methyl-, ethyl-, propyl-, isobutyl-, phenyl-residues, and/or 3-hydroxypropyl-residues, the latter might be modified via its oxygen in 3-position with a PEG (polyethylene glycol) chain. The PEG chain, if present, has a chain length of from 2 to 20 monomers, preferably from 3 to 18 monomers, especially from 5 or 8 to 11 or 15 monomers. Especially preferred residues are selected from methyl-, ethyl-, and the modified 3-hydroxypropyl-residues mentioned before. If an antifoaming agent is present, it is preferably present in an amount of from 0.2 % by weight to 5 % by weight, preferably from 0.5 % by weight to 3 % by weight.

[0023] The binder helps for a higher stability of the aqueous solution and thus also helps for a better processing. Suitable binders might be known binders such as soluble resins, acrylates, hydroxyethyl cellulose and/or polyvinylalkohol. Preferably, the binder is polyvinylalcohol (PVOH). If a binder is present, it is preferably in an amount of from 1 % by weight to 15 % by weight, preferably from 2 % by weight to 12 % by weight or to 10 % by weight, especially from 4 % by weight to 10 % by weight or to 8 % by weight, based on the total amount of the aqueous solution.

[0024] Preferably, the anti-pilling laundry sheet according to the present application has not only anti-pilling properties, since for the consumer the optical appearance and the smell are also of importance. Therefore, in a preferred embodiment the method of the present invention comprises that a perfume is applied to the substrate. This might either be the case in that a perfume is part of the aqueous solution. Alternatively, the perfume might be applied onto the substrate in an additional step, which is preferred. The amount of volatile components in the perfume is as low as possible so that even after storage an anti-pilling laundry sheet of the present invention has a pleasant scent.

[0025] The method of the present application includes the step of applying at least one aqueous solution with a flexographic printing machine. In a flexographic printing machine, at least one roller (or reel) is used to apply a defined amount of the aqueous solution to the substrate. In one preferred embodiment, the flexographic printing machine comprises applying the aqueous solution with one roller to the substrate to obtain the final amount of cellulase. Within the scope of the present invention, it is possible to apply the aqueous solution over the whole surface or over parts of the surface of the insoluble substrate at each and every roller.

[0026] In an alternative but also preferred embodiment, at the first roller not the whole amount of cellulase is applied to the substrate, but there is at least one further roller, so that at each roller of the flexographic printing machine an aqueous cellulase solution is applied to the substrate, to obtain the amount of the aqueous solution on the substrate to be within the range of from 1 gsm to 10 gsm. Preferably, a flexographic printing machine comprises more than one, e.g., two, three, four, five or six rollers.

[0027] In an alternative embodiment, at one roller a first aqueous solution is applied over the complete surface of the substrate, whereas at a second roller of the flexographic printing machine a second aqueous solution is applied only on parts of the surface of the substrate. This enables the application of a specific pattern on the surface. To obtain a pattern, the aqueous solution added on the first roller and the one added on the second roller in the flexographic printing machine are different from each other. E.g., they may differ in the presence of the additional components, preferably in the presence or in concentration of the colorant. Within the scope of the present invention, it is also possible that the concentration of the colorant is different so that different hues of the same color might be realized by the application at different rollers at the flexographic printing machine.

[0028] Thus, in a preferred embodiment the method of the present invention comprises in step (ii) not only providing one aqueous solution but comprising providing at least 2 and preferably from 2 to 6, especially from 3 to 5 aqueous solutions, comprising cellulase, wherein the solutions might be the same but could also be different and especially are different with respect to the presence and/or amount of colorant in the aqueous solutions.

[0029] The aqueous solution might also comprise a surfactant. Preferably, the aqueous solution is free of surfactant. If a surfactant is present, the amount is so low that it is not effective with respect of cleaning but might, without being bound to theory, help to release the cellulase from the sheet and therefore to improve the anti-pilling properties of the cellulase during the wash cycle. As the addition of surfactant to the aqueous solution and using said solution for flexographic printing is only possible for small amount of surfactants, the amount of surfactant, if present, is preferably less than 20 % by weight, preferably less than 15 % by weight, and especially of from 0 % by weight to 10 % by weight or from 2 % by weight to 7 % by weight, especially of from 0 % by weight to 5 % by weight.

[0030] The flexographic printing according to the present invention enables an accurate and efficient method to produce anti-pilling laundry sheets. Compared to rotary screen printing, as is disclosed for example in WO 2015/139865 A1, flexographic printing enables much faster running speed of the printing machine compared with the rotary screens. Therefore, in a preferred embodiment, the running speed of the flexographic printing machine is within a range of from 50 m/min to 150 m/min, especially from 70 m/min to 120 m/min, preferably from 80 m/min to 100 m/min.

[0031] This high running speed enables a high production rate and thus a cost- and time-efficient production of a sheet according to the present invention.

[0032] The application step in step (iii) is preferably performed at ambient temperature. Therefore, the temperature is preferably in a range of from 10 °C to 35 °C, especially from 15 °C to 25 °C, especially about 20 °C. Thus, no specific temperature profile is needed for the method according to the present invention. The aqueous solution is applied to the

substrate at ambient temperature. Due to the flexographic printing, no additional drying step is needed. Therefore, preferably the method according to the present invention does not comprise a step of drying the substrate at an elevated temperature of 35 °C or more, preferably of 25 °C or more, after step (iii). This also helps for a high activity of the cellulase on the sheet if used in laundry. Cellulase is an enzyme. Like most of the enzymes, cellulase is temperature sensitive. It degenerates at elevated temperature above approximately 60 °C resulting in reduced anti-pilling activity. As no drying or application step at elevated temperature above 60 °C is needed in the method according to the present application, the cellulase retains its anti-pilling activity.

[0033] The high printing speed combined with a high accuracy and the absence of an additional drying step enables the production of an anti-pilling sheet in one step only. The prior art uses other printing techniques, such as rotary screen printing, which require a drying step. As described in WO 2015/139865 A1, this drying step has to be performed in a second machine, being different from the printing machine. Thus, where the prior art only teaches two-step methods, the method according to the present invention now enables for the first time a one-step method for the production of a sheet and also for the first time a one-step production of an anti-pilling laundry sheet.

[0034] The water insoluble substrate of the present invention is preferably a non-woven. Said non-woven can be coated or uncoated prior to the application of the aqueous solution according to step (iii) of the present invention.

[0035] The substrate can be a woven, knitted or non-woven material and is preferably provided in form of a sheet. Preferably the substrate is a non-woven, especially a cellulose-based non-woven. Preferably it comprises a material, which provides free hydroxy groups at the surface of the substrate. The substrate can consist of one material, but it can also comprise mixtures of different materials. Preferably, the substrate comprises cellulosic and/or synthetic fibers. For example a blend of viscose and pulp fibers might be used. Also mixtures of cellulosic fibers and synthetic fibers or pulp fibers and viscose and synthetic fibers might be used.

[0036] The substrate thus preferably comprises cellulosic type fibers, such as linen, cotton (blends of different cotton are possible), or viscose. Suitable synthetic fibers would be polypropylene, polyethylene, polyamides, polyesters, or polyolefins. Any diameter or denier of fiber can be used in the present invention.

[0037] The substrate might further comprise additional fibers, preferably natural fibers, such as pulp fibers. The sheet might be wet-laid or spun-laid, defining the length of the fibers. It is preferred that the fibers have a length of about from 2 mm to 5 mm for wet-laid non-woven and/or from 30 mm to 50 mm for spun-laid non-woven.

[0038] If the substrate is coated, the substrate is preferably a cellulosic-based non-woven, which preferably comprises further natural fibers, especially pulp fibers. The coating is preferably a dye catching coating. Suitable dye catching coatings are mentioned in the prior art, e.g. in PCT/EP2017/050080, the content of which is enclosed in its entirety.

[0039] Therefore, preferably the substrate comprises a color-catching property, which can be obtained by suitable color-catching molecules, such as polyamines, or GMAC (glycidyltrimethylammoniumchloride), or a precursor of GMAC, such as 3-chloro-2-hydroxypropyltrimethylammonium chloride. Especially preferred color-catching molecule is GMAC or a precursor thereof. Said amended substrate is then used in step (i) in the method according to the present application. Therefore, step (i) of the method would comprise in a preferred embodiment:

(ia) providing a water-insoluble substrate,
(ib) providing dye catching molecules, preferably GMAC, or a precursor thereof, in a solution,
(ic) apply the dye catching molecules to the substrate and afterwards drying the thus obtained substrate.

[0040] Such a preferred method would thus enable to provide a laundry sheet not only with anti-pilling properties but also with dye catching properties. Thus, such a sheet would combine two specific problems which appear when washing colored clothes, especially clothes based on cotton based materials. Due to the color catching properties, no staining of clothes due to colors running into the wash liquor during laundry appears, resulting in a new and fresh appearance of the clothes. Due to the anti-pilling properties, no fuzz appears, which again helps to keep the fresh and new appearance of clothes particularly after several wash cycles.

[0041] In a further embodiment, the present application refers to an anti-pilling laundry sheet comprising

(α) a substrate and
(ß) a coating,

said sheet being obtainable by a method as described above.

[0042] The absorption capacity is a process parameter relevant for the production of the sheet. The absorption capacity is defined as the amount of standard cationic solution, which is absorbed by a substrate of a certain size in a mentioned period of time. To determine the absorption capacity, an aqueous solution (7.1 %) of a standard cationic compound (GMAC) is prepared and a sheet is placed inside said solution. The amount of said aqueous solution absorbed by the sheet within a certain time range at room temperature is determined.

[0043] The laundry sheet of the present invention preferably has a substrate with an absorption capacity of 2.5 g to 7

g per 277.5 cm^2 within an absorption time of 1.5 s to 5 s (seconds), preferably it has an absorption capacity of 2.5 g to 6 g per 277.5 cm^2 within an absorption time of 2 s to 4.5 s. The values refer to a sheet size of 277.5 cm^2, corresponding to a sheet with a size of 250 mm to 111 mm.

[0044] The laundry sheet of the present application is strong and robust to be suitable for all washing machine types. Strength and robustness might be defined by the tensile strength. Tensile strength refers to the resilience of the sheet against ripping. The direction of tensile strength can be distinguished between machine direction (MD) and cross direction (CD). When the laundry sheet is produced, the lengthwise direction (direction of production) is the machine direction. The direction rectangular thereto is the cross direction. Relevant is of course also the tensile strength in respect of moisture. Thus, the sheets should be robust and stable if wet - which means a sheet that is immersed for 10 seconds in water - as well as if dry - which means a sheet as can be obtained by a supplier.

[0045] Thus, the laundry sheet of the present application has, if wet, preferably a tensile strength in machine direction (MD) from 200 N/m to 1400 N/m, preferably from 300 N/m to 1200 N/m, especially from 400 N/m to 1000 N/m or to 1200 N/m, especially preferred from 550 N/m to 850 N/m and/or in cross direction (CD) from 100 N/m to 1000 N/m, preferably from 250 N/m to 800 N/m, especially preferred from 350 N/m to 600 N/m.

[0046] Thus, the laundry sheet of the present application has, if dry, preferably a tensile strength in machine direction (MD) from 1200 N/m to 2800 N/m, preferably from 1400 N/m to 2600 N/m, especially from 1600 N/m to 2400 N/m, especially preferred from 1800 N/m to 2200 N/m and/or in cross direction (CD) from 900 N/m to 2500 N/m, preferably from 1100 N/m to 2300 N/m, especially from 1300 N/m to 2100 N/m, especially preferred from 1500 N/m to 1900 N/m.

[0047] It has been found that respective tensile strengths enable stable and robust products which are at the same time flexible and permeable to washing liquor. At the same time, the feel is good so that consumers' requirements are also fulfilled here.

[0048] All values for tensile strength, wet and dry, as well as cross direction and machine direction, have been and can be determined using a standard testing machine from Zwick GmbH, Ulm, Germany. The tensile strength according to the present invention is determined according to ISO 9073-3 (of the year 1989).

[0049] The tensile strength in machine direction and cross direction is measured for wet as well as for dry states. It has been determined for the substrates prior to any coating and also after the coating. All measurements have shown that the coating influences only little the tensile strength of the sheet. It might slightly drop after applying the aqueous solution in step (iii) in the present application. The mentioned tensile strengths are thus for the substrate itself and also for the sheet according to the present invention.

[0050] With respect to the look and feel of the sheet, the thickness of the sheet is preferably from 0.62 mm to 1.5 mm, preferably from 1.0 mm to 1.2 mm. The thickness is especially relevant for the question of permeability. Thicker sheets might not be permeable to washing liquor. Thinner sheets might not be robust enough; especially in aggressive top loaders with spindles they might be destroyed. This would not lead to a reduced efficacy of the laundry sheet but to reduced approval by the consumer.

[0051] In a further aspect, the density of the substrate is preferably from 40 g/m^2 to 180 g/m^2, preferably from 50 g/m^2 to 150 g/m^2 or to 130 g/m^2, especially preferred from 55 g/m^2 to 120 g/m^2. This density is sufficient to provide a substrate to be coated with a sufficient amount of the aqueous solution. At the same time, it is possible to apply a color-catching molecule first on the substrate and afterwards coat the resulting substrate with the aqueous solution in a preferred embodiment. The density enables in this case a sufficient color-catching as well as a sufficient anti-pilling property of the sheet.

[0052] The density is determined according to ISO 9073-1 (of the year 1989) and is the density of the substrate prior to any coating. Such a density is preferred as respective sheets have an improved performance compared with other sheets. Especially if the sheets are not only anti-pilling sheets, but further comprise a dye catching coating, they can absorb large amounts of dyes from the washing liquor in short times compared with other dye catching laundry sheets. At the same time, the sheets are still flexible and water permeable, so that the consumer will accept them and also add them to delicate textile fabrics such as microfiber fabrics or others.

[0053] In the following examples, the present invention is further described in preferred embodiments but not limited. Specific embodiments and features of the embodiments are to be seen as disclosed for each and every embodiment so that features disclosed in the specification can be combined with each other with the embodiment still being within the scope of the present invention.

Examples

Example 1:

[0054] A non-woven comprising viscose and pulp fibers was coated with an aqueous solution comprising active cellulase enzyme protein in the amount of about 0.7% by weight to 0.8% by weight, based on the total weight of the aqueous solution.

[0055] The aqueous solution was applied on the substrate at room temperature (about 20 °C) at a speed of 80 m/min. The number of reels in the flexographic printing machine was 4. At each reel the same cellulase solution was applied onto the substrate.

[0056] After the sheet was treated in the machine, it was coiled on a capstan and stored prior to cutting it into suitable pieces for selling.

[0057] The amount of aqueous solution applied onto the substrate was 2.3 gsm.

Example 2:

[0058] The anti-pilling properties of the sheet according to the present invention was evaluated according to DIN ISO 12945-2:2000, where 5 is the best and 1 the worst value).

[0059] Textile stripes consisting of 94 % cotton (CO) and 6 % elastan (EL) were washed in a Miele W 1935 washing machine in the cotton program at 40 °C for 20 wash cycles. The strips were washed for 20 cycles without addition of an anti-pilling sheet according to the present invention.

[0060] The textile stripes were obtained from Empa Technology & Society Laboratory, St. Gallen, Switzerland.

[0061] First, the stripes were evaluated in view of the pilling prior to any wash cycle. This resulted in an initial value of 5.0 (line 1 "Initial value" in table 1).

[0062] The stripes were afterwards washed with two different detergents which were solutions of nonionic and anionic surfactants with protease, cellulase and lipase enzymes. The detergents are commercially available.

[0063] The detergents were used alone as comparison examples (Examples A and C) and together with a sheet according to the present invention (Examples B, and D). In Examples A, and B the same detergent was used. Also in Examples C and D the same detergent was used.

[0064] The first line of table 1 shows the result of new textiles prior and after 20 wash cycles (labeled "original"). The lower part of each table (labeled "prepilled") shows the result for prepilled textiles, which is also apparent from the initial evaluation value.

[0065] Thus, line 1 of table 1 shows that the sheet of the present invention is able to reduce the amount of fuzz occurring on new sheets during washing.

[0066] Lines 2 and 3 of table 1 show, that the sheet according to the present invention is further able to reduce the amount of fuzz already being present on textiles prior to the washing.

[0067] Thus, the sheet of the present invention not only enables a longer new appearance of new textiles but also refreshes the appearance of used fuzzed textiles.

Table 1: Execution Examples

Evaluation according to DIN EN ISO 12945-2: 2000 Grade 5 = best value / Grade 1 = worst value					
	Initial value (original textile)	A	B	C	D
Textiles					
	original				
1. Textile stripes of 94 % CO, 6 % EL	5,0	2,9	3,2	2,7	3,5
	prepilled				
2. Textile stripes of 94 % CO, 6 % EL	2,0	2,8	3,6	2,7	3,5
3. Textile stripes of 94 % CO, 6 % EL (+ 14 wash cycles)	1,2	4,0	4,4	3,8	4,4
mean value	**1,6**	**3,4**	**4,0**	**3,3**	**4,0**

Claims

1. Method of preparing a laundry sheet with anti-pilling properties comprising:

(i) providing a water insoluble substrate,
(ii) providing at least one aqueous solution comprising from 0.01 % by weight to 4 % by weight, based on the total weight of the solution, of active cellulase enzyme protein,
(iii) applying the aqueous solution onto the substrate with a flexographic printing machine such that the amount of the aqueous solution on the substrate after the coating is within a range from 1 gsm to 10 gsm.

2. Method according to claim 1, wherein the aqueous solution comprises

(a) from 40 % by weight to 95 % by weight of water and
(b) from 0.01 % by weight to 4 % by weight active cellulase enzyme protein,

based on the total weight of the solution.

3. Method according to claim 2, wherein the aqueous solution further comprises one or more selected from a binder, an antifoaming agent, a surfactant, a colorant, a perfume, or mixtures of these.

4. Method according to claim 3, wherein the amount of surfactant is less than 20 % by weight, preferably less than 15 % by weight, especially of from 0 % by weight to 10 % by weight.

5. Method according to any of claims 1 to 4, wherein the running speed of the printing machine is within a range from 50 m/min to 150 m/min, preferably from 80 m/min to 100 m/min.

6. Method according to any of claims 1 to 5, wherein the application in step (iii) is performed at a temperature of from 10 °C to 35 °C, preferably from 15 °C to 25 °C.

7. Method according to any of claims 1 to 6, wherein the method does not comprise a step of drying the substrate at an elevated temperature of 35 °C or more after step (iii).

8. Method according to any of claims 1 to 7, wherein the substrate is a coated or uncoated non-woven.

9. Method according to claim 8, wherein the substrate is cellulose or pulp fiber based non-woven.

10. Method according to claim 8 and 9, wherein the substrate is a non-woven comprising cellulose or pulp fiber coated with a dye-catching material.

12. Method according to any of claims 8 to 10, wherein the substrate further comprises fibers, especially natural fibers.

13. Anti-pilling laundry sheet comprising

(α) a substrate and
(ß) a coating,

said sheet being obtainable by a method according to any of the proceeding claims.

14. Sheet according to claim 13, having a tensile strength in machine direction (MD) from 200 N/m to 1400 N/m, preferably from 300 N/m to 1200 N/m, especially from 400 N/m to 1000 N/m or to 1200 N/m, especially preferred from 550 N/m to 850 N/m, if wet.

15. Sheet according to claim 13 or 14, having a tensile strength in cross direction (CD) from 100 N/m to 1000 N/m, preferably from 250 N/m to 800 N/m, especially preferred from 350 N/m to 600 N/m, if wet.

16. Sheet according to any of claims 13 to 15, having a tensile strength, if dry, in machine direction (MD) from 1200 N/m to 2800 N/m, preferably from 1400 N/m to 2600 N/m, especially from 1600 N/m to 2400 N/m, especially preferred from 1800 N/m to 2200 N/m.

17. Sheet according to any of claims 13 to 15, having a tensile strength, if dry, in cross direction (CD) from 900 N/m to 2500 N/m, preferably from 1100 N/m to 2300 N/m, especially from 1300 N/m to 2100 N/m, especially preferred from 1500 N/m to 1900 N/m.

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EUROPEAN SEARCH REPORT

Application Number
EP 17 17 4650

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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