

efficient conversion of high rush transfer levels to high MD stretch while throughdrying fabrics are designed to deliver bulk and CD stretch. It is therefore useful to have moderately coarse and moderately three-dimensional transfer fabrics and throughdrying fabrics which are quite coarse and three dimensional in the optimized configuration. The result is that a relatively smooth sheet leaves the transfer section and then is macroscopically rearranged (with vacuum assist) to give the high bulk, high CD stretch surface topology of the throughdrying fabric. Sheet topology is completely changed from transfer to throughdrying fabric and fibers are macroscopically rearranged, including significant fiber-fiber movement.

[0075] The drying process can be any noncompressive drying method which tends to preserve the bulk or thickness of the wet web including, without limitation, throughdrying, infra-red radiation, microwave drying, etc. Because of its commercial availability and practicality, throughdrying is well known and is one commonly used means for noncompressively drying the web for purposes of this invention. Suitable throughdrying fabrics include, without limitation, fabrics with substantially continuous machine direction ridges whereby the ridges are made up of multiple warp strands grouped together, such as those disclosed in US Patent No. 6,998,024. Other suitable throughdrying fabrics include those disclosed in US Patent No. 7,611,607, particularly the fabrics denoted as Fred (t1207-77), Jeston (t1207-6) and Jack (t1207-12). The web is preferably dried to final dryness on the throughdrying fabric, without being pressed against the surface of a Yankee dryer, and without subsequent creping.

[0076] Once the wet tissue web 6 has been non-compressively dried, thereby forming the dried tissue web 15, it is possible to crepe the dried tissue web 15 by transferring the dried tissue web 15 to a Yankee dryer prior to reeling, or using alternative foreshortening methods such as microcreping as disclosed in US Patent No. 4,919,877.

[0077] In the wound product, it is often advantageous to wind the product with the softest side facing the consumer, and hence the shearing process to increase the softness of this side is preferred. However, it is also possible to treat the air side of the web rather than the fabric side, and in these embodiments, it would be possible to increase the air-side softness to a level higher than that of the fabric side.

[0078] The process of the present disclosure is well suited to forming multi-ply tissue products. The multi-ply tissue products can contain two plies, three plies, or a greater number of plies. In one particular embodiment, a two-ply rolled tissue product is formed according to the present disclosure in which both plies are manufactured using the same papermaking process, such as, for example, uncreped through-air dried. However, in other embodiments, the plies may be formed by two different processes. Generally, prior to being wound in a roll, the first ply and the second ply are attached together. Any suitable manner for laminating the webs together may be used. For example, the process includes a crimping device that causes the plies to mechanically attach together through fiber entanglement. In an alternative embodiment, however, an adhesive may be used in order to attach the plies together.

[0079] Additionally, webs prepared according to the present disclosure may be subjected to any suitable post processing including, but not limited to, printing, embossing, calendaring, slitting, folding, combining with other fibrous structures, and the like.

[0080] By combining bamboo fibers in a tissue web in this manner, the disclosure provides tissue webs having surprising characteristics. For example, through-air dried tissue webs comprising bamboo have improved bulk, without a loss of durability or softness. Table 2 below shows a comparison of through-air dried and conventional wet pressed control webs comprising hardwood and softwood fibers with comparable webs wherein the softwood fiber has been replaced with either bamboo or hardwood Eucalyptus fiber, respectively. As shown in Table 2, the addition of bamboo to the web results in an increase in sheet bulk without negatively effecting durability or softness. However, this effect is only observed for through-air dried tissue webs. When the web is manufactured using conventional wet pressed techniques the bulk actually decreases, while durability and softness are negatively affected. Similarly, replacement of the softwood fiber with hardwood fiber, while resulting in an increase in bulk, causes a decrease in both durability and softness.

TABLE 2

Control	Bamboo			Eucalyptus		
	Delta Bulk	Delta Durability Index	Delta Stiffness Index	Delta Bulk	Delta Durability Index	Delta Stiffness Index
TAD Web	7.7%	-0.8%	12.7%	7.9%	-14.8%	30.1%
CWP Web	-10.9%	-20.6%	31.4%	-7.0%	-30.5%	30.3%

TEST METHODS

Sheet Bulk

5 **[0081]** Sheet Bulk is calculated as the quotient of the dry sheet caliper expressed in microns, divided by the dry basis weight, expressed in grams per square meter. The resulting Sheet Bulk is expressed in cubic centimeters per gram. More specifically, the Sheet Bulk is the representative thickness of a single tissue sheet measured in accordance with TAPPI test methods T402 "Standard Conditioning and Testing Atmosphere For Paper, Board, Pulp Handsheets and Related Products" and T411 om-89 "Thickness (caliper) of Paper, Paperboard, and Combined Board." The micrometer
10 used for carrying out T411 om-89 is an Emveco 200-A Tissue Caliper Tester (Emveco, Inc., Newberg, OR). The micrometer has a load of 2 kilo-Pascals, a pressure foot area of 2500 square millimeters, a pressure foot diameter of 56.42 millimeters, a dwell time of 3 seconds and a lowering rate of 0.8 millimeters per second.

Tear

15 **[0082]** Tear testing was carried out in accordance with TAPPI test method T-414 "Internal Tearing Resistance of Paper (Elmendorf-type method)" using a falling pendulum instrument such as Lorentzen & Wettre Model SE 009. Tear strength is directional and MD and CD tear are measured independently.

[0083] More particularly, a rectangular test specimen of the sample to be tested is cut out of the tissue product or tissue basesheet such that the test specimen measures $63 \text{ mm} \pm 0.15 \text{ mm}$ ($2.5 \text{ inches} \pm 0.006''$) in the direction to be tested (such as the MD or CD direction) and between 73 and 114 millimeters (2.9 and 4.6 inches) in the other direction. The specimen edges must be cut parallel and perpendicular to the testing direction (not skewed). Any suitable cutting device, capable of the proscribed precision and accuracy, can be used. The test specimen should be taken from areas of the sample that are free of folds, wrinkles, crimp lines, perforations or any other distortions that would make the test
25 specimen abnormal from the rest of the material.

[0084] The number of plies or sheets to test is determined based on the number of plies or sheets required for the test results to fall between 20 to 80 percent on the linear range scale of the tear tester and more preferably between 20 to 60 percent of the linear range scale of the tear tester. The sample preferably should be cut no closer than 6 mm (0.25 inch) from the edge of the material from which the specimens will be cut. When testing requires more than one sheet
30 or ply the sheets are placed facing in the same direction.

[0085] The test specimen is then placed between the clamps of the falling pendulum apparatus with the edge of the specimen aligned with the front edge of the clamp. The clamps are closed and a 20-millimeter slit is cut into the leading edge of the specimen usually by a cutting knife attached to the instrument. For example, on the Lorentzen & Wettre Model SE 009 the slit is created by pushing down on the cutting knife lever until it reaches its stop. The slit should be
35 clean with no tears or nicks as this slit will serve to start the tear during the subsequent test.

[0086] The pendulum is released and the tear value, which is the force required to completely tear the test specimen, is recorded. The test is repeated a total of ten times for each sample and the average of the ten readings reported as the tear strength. Tear strength is reported in units of grams of force (gf). The average tear value is the tear strength for the direction (MD or CD) tested. The "geometric mean tear strength" is the square root of the product of the average MD tear strength and the average CD tear strength. The Lorentzen & Wettre Model SE 009 has a setting for the number of plies tested. Some testers may need to have the reported tear strength multiplied by a factor to give a per ply tear strength. For basesheets intended to be multiple ply products, the tear results are reported as the tear of the multiple ply product and not the single ply basesheet. This is done by multiplying the single ply basesheet tear value by the number of plies in the finished product. Similarly, multiple ply finished product data for tear is presented as the tear strength for the finished product sheet and not the individual plies. A variety of means can be used to calculate but in general will be done by inputting the number of sheets to be tested rather than number of plies to be tested into the measuring device. For example, two sheets would be two 1-ply sheets for 1-ply product and two 2-ply sheets (4-plyes)
45 for 2-ply products.

Tensile

50 **[0087]** Tensile testing was done in accordance with TAPPI test method T-576 "Tensile properties of towel and tissue products (using constant rate of elongation)" wherein the testing is conducted on a tensile testing machine maintaining a constant rate of elongation and the width of each specimen tested is 3 inches. More specifically, samples for dry tensile strength testing were prepared by cutting a $3 \text{ inches} \pm 0.05''$ ($76.2 \text{ mm} \pm 1.3 \text{ mm}$) wide strip in either the machine
55 direction (MD) or cross-machine direction (CD) orientation using a JDC Precision Sample Cutter (Thwing-Albert Instrument Company, Philadelphia, PA, Model No. JDC 3-10, Serial No. 37333) or equivalent. The instrument used for measuring tensile strengths was an MTS Systems Sintech 11S, Serial No. 6233. The data acquisition software was an MTS

TestWorks® for Windows Ver. 3.10 (MTS Systems Corp., Research Triangle Park, NC). The load cell was selected from either a 50 Newton or 100 Newton maximum, depending on the strength of the sample being tested, such that the majority of peak load values fall between 10 to 90 percent of the load cell's full scale value. The gauge length between jaws was 4 ± 0.04 inches (101.6 ± 1 mm) for facial tissue and towels and 2 ± 0.02 inches (50.8 ± 0.5 mm) for bath tissue. The crosshead speed was 10 ± 0.4 inches/min (254 ± 1 mm/min), and the break sensitivity was set at 65 percent. The sample was placed in the jaws of the instrument, centered both vertically and horizontally. The test was then started and ended when the specimen broke. The peak load was recorded as either the "MD tensile strength" or the "CD tensile strength" of the specimen depending on direction of the sample being tested. Ten representative specimens were tested for each product or sheet and the arithmetic average of all individual specimen tests was recorded as the appropriate MD or CD tensile strength the product or sheet in units of grams of force per 3 inches of sample. The geometric mean tensile (GMT) strength was calculated and is expressed as grams-force per 3 inches of sample width. Tensile energy absorbed (TEA) and slope are also calculated by the tensile tester. TEA is reported in units of gm cm/cm². Slope is recorded in units of kg. Both TEA and Slope are directional dependent and thus MD and CD directions are measured independently. Geometric mean TEA and geometric mean slope are defined as the square root of the product of the representative MD and CD values for the given property.

[0088] Multi-ply products were tested as multi-ply products and results represent the tensile strength of the total product. For example, a 2-ply product was tested as a 2-ply product and recorded as such. A basesheet intended to be used for a two ply product was tested as two plies and the tensile recorded as such. Alternatively, a single ply may be tested and the result multiplied by the number of plies in the final product to get the tensile strength.

Burst Strength

[0089] Burst strength herein is a measure of the ability of a fibrous structure to absorb energy, when subjected to deformation normal to the plane of the fibrous structure. Burst strength may be measured in general accordance with ASTM D-6548 with the exception that the testing is done on a Constant-Rate-of-Extension (MTS Systems Corporation, Eden Prairie, MN) tensile tester with a computer-based data acquisition and frame control system, where the load cell is positioned above the specimen clamp such that the penetration member is lowered into the test specimen causing it to rupture. The arrangement of the load cell and the specimen is opposite that illustrated in FIG. 1 of ASTM D-6548. The penetration assembly consists of a semi spherical anodized aluminum penetration member having a diameter of 1.588 ± 0.005 cm affixed to an adjustable rod having a ball end socket. The test specimen is secured in a specimen clamp consisting of upper and lower concentric rings of aluminum between which the sample is held firmly by mechanical clamping during testing. The specimen clamping rings has an internal diameter of 8.89 ± 0.03 cm.

[0090] The tensile tester is set up such that the crosshead speed is 15.2 cm/min, the probe separation is 104 mm, the break sensitivity is 60 percent and the slack compensation is 10 gf and the instrument is calibrated according to the manufacturer's instructions.

[0091] Samples are conditioned under TAPPI conditions and cut into 127×127 mm ± 5 mm squares. For each test a total of 3 sheets of product are combined. The sheets are stacked on top of one another in a manner such that the machine direction of the sheets is aligned. Where samples comprise multiple plies, the plies are not separated for testing. In each instance the test sample comprises 3 sheets of product. For example, if the product is a 2-ply tissue product, 3 sheets of product, totaling 6 plies are tested. If the product is a single ply tissue product, then 3 sheets of product totaling 3 plies are tested.

[0092] Prior to testing the height of the probe is adjusted as necessary by inserting the burst fixture into the bottom of the tensile tester and lowering the probe until it was positioned approximately 12.7 mm above the alignment plate. The length of the probe is then adjusted until it rests in the recessed area of the alignment plate when lowered.

[0093] It is recommended to use a load cell in which the majority of the peak load results fall between 10 and 90% of the capacity of the load cell. To determine the most appropriate load cell for testing, samples are initially tested to determine peak load. If peak load is < 450 gf a 10 Newton load cell is used, if peak load is > 450 gf a 50 Newton load cell is used.

[0094] Once the apparatus is set-up and a load cell selected, samples are tested by inserting the sample into the specimen clamp and clamping the test sample in place. The test sequence is then activated, causing the penetration assembly to be lowered at the rate and distance specified above. Upon rupture of the test specimen by the penetration assembly the measured resistance to penetration force is displayed and recorded. The specimen clamp is then released to remove the sample and ready the apparatus for the next test.

[0095] The peak load (gf) and energy to peak (g-cm) are recorded and the process repeated for all remaining specimens. A minimum of five specimens are tested per sample and the peak load average of five tests is reported as the Dry Burst Strength.

EXAMPLES

Example 1: Conventional Wet Pressed Tissue Comprising Bamboo

- 5 **[0096]** Sample codes were made using a wet pressed process utilizing a Crescent Former. Accordingly, single ply bath and two ply facial tissue products were produced and tested according to the same tests described in the Test Methods section. The following tissue manufacturing process was used to produce the sample codes.
- [0097]** Initially, northern softwood kraft ("NSWK") pulp was dispersed in a pulper for 30 minutes at 3 percent consistency at about 100° F. In certain instances, as indicated in the tables below, NSWK pulp was refined at 1.5 to 5.0 hp-days/metric ton. The NSWK pulp was then transferred to a dump chest and subsequently diluted to approximately 0.75 percent consistency. Once diluted, in certain instances Kymene® 920A and/or Hercobond® 1366 (both available from Ashland, Covington, KY) was added to the NSWK. When utilized in a multi-layered tissue web, NSWK fibers were added to the middle layer of the 3-layered tissue web.
- 10 **[0098]** Aracruz ECF, a eucalyptus hardwood kraft ("EHWK") pulp (Aracruz, Rio de Janeiro, RJ, Brazil) was dispersed in a pulper for 30 minutes at about 3 percent consistency at about 100° F. The EHWK pulp was then transferred to a dump chest and subsequently diluted to about 0.75 percent consistency. The EHWK pulp fibers were used in the two outer layers of the 3-layered tissue structure.
- [0099]** Commercial bleached bamboo pulps were obtained from Guizhou Chitianhua Paper Co., Ltd., Guizhou, China (herein after "Chinese Bamboo") and Phoenix Pulp and Paper PCL, Khon - Kaen, Thailand (hereinafter "Thai Bamboo"). The Chinese Bamboo was a mixture of 3 species of tropical bamboo *Neosinocalamus affinis*, *Bambusa rigida*, and *Bambusa pervariabilis* × *Dendrocalamopsis Daii*. The Chinese Bamboo was pulped by a TCF sulfate process. The Thai Bamboo was an ECF Bleached Kraft pulp consisting of a mixture of four tropical bamboo species: *Bambusa Blumeana*, *Bambusa Tulda*, *Bambusa Nana* and *Dendrocalamus Asper*.
- 20 **[0100]** Moso Bamboo pulp fibers were prepared from chipped green Moso bamboo poles by a Kraft pulp process using Na₂S and NaOH for digestion followed by oxygen delignification and bleaching with chlorine dioxide. After bleaching the pulp was dried to 30 to 50 percent consistency on a belt press to form a never dried crumb pulp. Never dried pulp was converted to dry lap pulp having a basis weight of around 250 g/m² by slurring 350 oven dried basis pounds of bamboo crumb pulp in 1400 gallons of water in a hydropulper at about 125°F. The slurry was pulped for about 20 minutes to give 3 percent consistency bamboo pulp slurry. The slurry was passed to a headbox and deposited on a Fourdiner forming belt moving at about 90 feet per minute and dewatered. Minimal pressing was done in the water removal process using only the roll weights in the wet press section of the machine. The dewatered pulp sheet was then passed over three stacks of calendar dryers, dried and rolled on 4-inch cores. Steam pressures in the calendar stacks were controlled to provide a dry lap pulp having between 6 and 8 percent moisture.
- 25 **[0101]** Bamboo or NSWK pulp fibers were dispersed in a pulper for 25 minutes at 3 percent consistency at about 100° F. In certain instances, as indicated in the tables below, the bamboo pulp was refined at 1.5 to 5.0 hp-days/metric ton. The bamboo or NSWK pulp was then transferred to a dump chest and subsequently diluted to approximately 0.75 percent consistency. Once diluted, in certain instances Kymene® 920A and/or Hercobond® 1366 were added to the NSWK. When utilized in a multi-layered tissue web, bamboo and NSWK fibers were added to the middle layer of the 3-layered tissue web.
- 30 **[0102]** Similarly Bleached Eucalyptus Hardwood Kraft pulp fibers obtained from Fibria, S.A., were dispersed in a pulper for 25 minutes at 3 percent consistency at 100°F. The Eucalyptus pulp slurry was then transferred to a dump chest and subsequently diluted to approximately 0.75 percent consistency. Once diluted, in certain instances Kymene® 920A, Hercobond® 1366, were added to the NSWK. When utilized in a multi-layered tissue web, bamboo and NSWK fibers were added to the middle layer of the 3-layered tissue web.
- 35 **[0103]** In certain instances the pulp fibers from the machine chests were pumped to the headbox at a consistency of about 0.1 percent. Pulp fibers from each machine chest were sent through separate manifolds in the headbox to create a 3-layered tissue structure. The flow rates of the stock pulp fiber slurries into the flow spreader were adjusted to give a target web basis. In those instances where a layer structure was produced, flow of stock pulp fiber slurries was controlled to provide a layer split of about 30 to about 35 percent by total weight of the tissue web EHWK fibers on both outer layers and 30 to about 40 percent NSWK or bamboo pulp fibers in the center layer. The fibers were deposited onto a felt in using a Crescent Former.
- 40 **[0104]** In other instances a blended web was produced by weighing out the appropriate amount of the first pulp fiber into the pulper and dispersing for 30 minutes at 3 percent consistency at about 100° F. In some instances the pulp was refined at 1.5 to 5.0 hp-days/metric ton. The first pulp slurry was then transferred equally to three dump chests. The amount of the second pulp fiber was then weighed into the pulper and dispersed and refined in similar fashion if so required. The second pulp slurry was then transferred equally to the three dump chests. The three dump chests now contained a blended mix of the fibers. The dump chests were subsequently diluted to approximately 0.75 percent consistency. Once diluted, in certain instances Kymene® 920A and/or Hercobond® 1366 were added to the blended
- 45 50 55

furnishes in the dump chests. The blended slurries were then diluted to approximately 0.1 percent consistency before being pumped to a 3-layer headbox such that all 3-layer splits were evenly distributed. Alternatively, when no refining was required, the pulps could be blended together in the pulper per the procedure proscribed and then the blended slurry transferred from the pulper to the machine chests.

[0105] The wet sheet, about 10 to 20 percent consistency, was adhered to a Yankee dryer, traveling at about 80 to 120 fpm through a nip via a pressure roll.

[0106] The consistency of the wet sheet after the pressure roll nip (post-pressure roll consistency or PPRC) was approximately 40 percent. A spray boom situated underneath the Yankee dryer sprayed a creping composition at a pressure of 60 psi at a rate of approximately 0.25 g solids / m² of product. The creping composition comprised 0.16 percent by weight of polyvinyl alcohol (PVOH), (Celvol[™] 523 available from Celanese Chemicals, Calvert City, KY), 0.013 percent by weight PAE resin (Kymene[™] 6500 available from Ashland, Covington, KY) and 0.0013 percent by weight of Resozol[™] 2008 (Ashland, Covington, KY).

[0107] The sheet was dried to about 98 to 99 percent consistency as it traveled on the Yankee dryer and to the creping blade. The creping blade subsequently scraped the tissue sheet and a portion of the creping composition off the Yankee dryer. The creped tissue basesheet was then wound onto a core traveling at about 50 to about 100 fpm into soft rolls for converting.

[0108] To produce the 2-ply facial tissue products (Sample Nos. 1-4), two soft rolls of the creped tissue were then rewound, calendared, and plied together so that both creped sides were on the outside of the 2-ply structure. Mechanical crimping on the edges of the structure held the plies together. The plied sheet was then slit on the edges to a standard width of approximately 8.5 inches and folded, and cut to facial tissue length. Tissue samples were conditioned and tested.

[0109] Samples produced according to the present example are summarized in Table 3, below.

TABLE 3

Sample	Single Ply Basis Weight (gsm)	Web Structure	Plies	NSWK (wt %)	EHWK (wt %)	Bamboo (wt %)
1	15.1	Layered	2	30	70	0
2	15.1	Layered	2	40	60	0
3	15.1	Layered	2	0	70	30
4	15.1	Layered	2	0	60	40
5	16.7	Blended	1	40	60	0
6	16.7	Blended	1	40	60	0
7	16.7	Blended	1	0	100	0
8	16.7	Blended	1	0	100	0
9	16.7	Blended	1	0	60	40
10	16.7	Blended	1	0	60	40

Example 2: Uncreped Through-air Dried Tissue Comprising Bamboo

[0110] A single ply through-air dried tissue web was made generally in accordance with US Patent No. 5,607,551, which is herein incorporated by reference in a manner consistent with the present disclosure.

[0111] More specifically, from about 60 to about 100 pounds (about 27.2 to about 45.4kg) (oven dry basis) of Aracruz ECF, a eucalyptus hardwood kraft ("EHWK") pulp (Aracruz, Rio de Janeiro, RJ, Brazil) was dispersed in a pulper at 100°F for 25 minutes at a consistency of 3 percent before being transferred in equal parts to two machine chests and diluted to a consistency of 1 percent. When used, Hercobond 1366 was weighed out and diluted to a 1 percent actives solution with water prior to being added to the machine chest. The fiber slurry and chemical was allowed to mix for five minutes prior to the stock solution being sent to the headbox.

[0112] Forty pounds (oven dry basis) of northern softwood kraft fiber ("NSWK") (or bamboo pulp when used) were dispersed in a pulper at 100°F for 25 minutes at a consistency of 3 percent before being transferred to a second machine chest and diluted to 1 percent consistency. The softwood fibers may be refined after pulping and prior to transfer to the machine chest as noted in examples.

[0113] To produce a layered tissue web, prior to forming each stock was further diluted to approximately 0.1 percent consistency and transferred to a 3-layer headbox in such a manner as to provide a layered sheet. The fiber composition of the layered sheets are described in the table below. Generally, the outer layers comprised EHWK and the inner layer

comprised NSWK, bamboo fibers or a mixture of both.

[0114] Blended tissue webs were produced as described above.

[0115] The formed web was non-compressively dewatered and rush transferred to a transfer fabric traveling at a speed about 25 percent slower than the forming fabric. The web was then transferred to a throughdrying fabric and dried. Samples 11-15 were converted into rolled products to produce single ply bath tissue products. Samples were produced as described in Table 4, below.

TABLE 4

Sample	Basis Weight (gsm)	Web Structure	Basesheet or Finished Product	Plies	NSWK (wt%)	EHWK (wt%)	Bamboo (wt %)
11	27.1	Layered	Finished	1	35	65	0
12	27.1	Layered	Finished	1	25	65	10
13	27.1	Layered	Finished	1	10	65	25
14	27.1	Layered	Finished	1	0	65	35
15	27.1	NA	Finished	1	0	0	100
16	27.1	NA	Finished	1	0	100	0
17	36.5	NA	Basesheet	1	0	100	0
18	36.5	Layered	Basesheet	1	0	60	40
19	36.5	Layered	Basesheet	1	40	60	0
20	36.5	NA	Basesheet	1	0	100	0
21	36.5	Layered	Basesheet	1	0	50	50
22	36.5	Layered	Basesheet	1	0	60	40
23	36.5	Layered	Basesheet	1	40	60	0
24	36.5	Layered	Basesheet	1	40	60	0
25	36.5	Layered	Basesheet	1	0	60	40

Example 3: Uncreped Through-air Dried Towels Comprising Bamboo

[0116] A single ply uncreped through-air dried (UCTAD) tissue web was made generally in accordance with US Patent No. 5,607,551.

[0117] More specifically, from about 50 to about 90 pounds (about 22.7 to about 40.8kg) (oven dry basis) of Aracruz ECF, a EHWK pulp (Aracruz, Rio de Janeiro, RJ, Brazil) was dispersed in a pulper for 25 minutes with from about 10 to about 50 pounds (about 4.5 to about 22.7kg) of bleached chemi-thermo mechanical pulp ("BCTMP") at a consistency of 3 percent before being transferred in equal parts to three machine chests and diluted to a consistency of 1 percent.

[0118] Forty pounds (oven dry basis) of NSWK pulp (or bamboo pulp when used) was dispersed in a pulper for 25 minutes at a consistency of 3 percent and refined at between 1 and 5 horsepower tons/day before being transferred in equal parts to the three machine chests containing the EHWK and BCTMP fibers. The machine chests were then diluted to a consistency of 1 percent. Kymene 920A was added to each machine chest at the rate of 1 percent dry actives to oven dried basis of total pulp. The stock solutions were then passed in equal amounts to a 3-layer headbox after dilution to 0.75 percent consistency to form a blended sheet.

[0119] The formed web was non-compressively dewatered and rush transferred to a transfer fabric traveling at a speed about 25 percent slower than the forming fabric. The web was then transferred to a throughdrying fabric, dried and calendared. Samples were produced as described in Table 5, below.

TABLE 5

Sample	Single Ply Basis Weight (gsm)	Web Structure	Plies	Bamboo (wt%)	NSWK (wt%)	EHWK (wt %)	BCTMP (wt%)
26	39.0	Blended	1	0	50	25	25

(continued)

5	Sample	Single Ply Basis Weight (gsm)	Web Structure	Plies	Bamboo (wt%)	NSWK (wt%)	EHWK (wt %)	BCTMP (wt%)
	27	39.0	Blended	1	70	0	5	25

Web Strength and Bulk

10 [0120] The effect of bamboo on various tissue strength and durability properties was explored by preparing samples using several levels of bamboo. Table 6 summarizes the physical properties of basesheets prepared as described above. Table 7 summarizes the physical properties of finished produce prepared as described above.

TABLE 6

15	Sample	Single Ply Basis Weight (gsm)	Plies	Bamboo Total Web (wt%)	Bulk (cm ³ /g)	GMT (g/ 3")	TEA Index	CD TEA (g•cm/cm ²)
	1	15.1	2	0	9.5	924	10.3	3.6
	2	15.1	2	0	11.3	1235	10.2	4.9
20	3	15.1	2	30	9.0	1158	9.3	3.9
	4	15.1	2	40	8.9	1116	10.1	4.8
	5	16.7	1	0	9.7	1061	15.0	6.6
25	6	16.7	1	0	10.4	656	15.8	4.3
	7	16.7	1	0	9.3	728	12.7	3.8
	8	16.7	1	0	9.3	1024	12.4	5.2
	9	16.7	1	40	9.1	1158	11.2	5.5
30	10	16.7	1	40	9.2	758	12.6	4.3
	11	27.1	1	0	9.4	625	8.5	3.3
	12	27.1	1	10	9.8	769	8.9	4.2
35	13	27.1	1	25	10.9	557	8.5	3.2
	14	27.1	1	35	10.1	662	9.3	4.2
	15	27.1	1	100	10.3	954	10.1	6.5
	16	27.1	1	0	9.8	857	8.1	5.0
40	17	36.5	1	0	21.2	1160	11.2	8.8
	18	36.5	1	40	21.9	1089	13.3	10.1
	19	36.5	1	0	20.4	1051	12.0	8.9
45	20	36.5	1	0	22.1	1056	12.0	8.7
	21	36.5	1	50	21.5	968	13.3	10.5
	22	36.5	1	40	21.0	1167	13.6	13.7
	23	36.5	1	0	19.8	1160	13.4	9.6
50	24	36.5	1	0	20.5	1248	14.7	11.3
	25	36.5	1	40	22.0	1136	13.0	10.2
	26	39.0	1	0	20.8	2738	10.9	17.7
55	27	39.0	1	70	22.6	1616	10.1	12.5

[0121] The relative change in bulk (Delta Bulk %), compared to a control to an identical control containing NBSK in

place of bamboo, is summarized in the table below.

TABLE 7

Sample	Basis Weight (gsm)	Web Structure	Plies	Method of Manufacture	Bamboo Total Web (wt%)	Bulk (cm ³ /g)	Delta Bulk (%)
3	15.1	Layered	2	CWP	30	9.0	-4.5%
4	15.1	Layered	2	CWP	40	8.9	-21.4%
9	16.7	Blended	1	CWP	40	9.1	-6.2%
10	16.7	Blended	1	CWP	40	9.2	-11.7%
12	27.1	Layered	1	UCTAD	10	9.8	3.5%
13	27.1	Layered	1	UCTAD	25	10.9	15.1%
14	27.1	Layered	1	UCTAD	35	10.1	7.1%
15	27.1	Blended	1	UCTAD	100	10.3	9.4%
18	36.5	Layered	1	UCTAD	40	21.9	7.6%
21	36.5	Layered	1	UCTAD	50	21.5	8.6%
22	36.5	Layered	1	UCTAD	40	21.0	5.9%
25	36.5	Layered	1	UCTAD	40	22.0	7.3%
27	39.0	Blended	1	UCTAD	70	22.6	8.7%

Web Softness and Durability

[0122] The effect of bamboo on the durability (Durability Index) and softness (Stiffness Index) of the tissue web was explored by preparing samples using several levels of bamboo, the results of which are summarized below.

TABLE 8

Sample	Basis Weight (gsm)	Web Structure	Plies	Bamboo Total Web (wt%)	Tear Index	Stiffness Index	Durability Index
1	15.1	Layered	2	0	10.3	9.4	24.3
2	15.1	Layered	2	0	10.2	10.0	23.2
3	15.1	Layered	2	30	9.3	12.7	19.8
4	15.1	Layered	2	40	10.1	13.0	21.2
5	16.7	Blended	1	0	15.0	9.1	30.2
6	16.7	Blended	1	0	15.8	8.4	33.1
7	16.7	Blended	1	0	12.7	8.6	23.5
8	16.7	Blended	1	0	12.4	9.3	20.5
9	16.7	Blended	1	40	11.2	10.2	20.6
10	16.7	Blended	1	40	12.6	13.3	27.3
11	27.1	Layered	1	0	8.49	10.9	25.6
12	27.1	Layered	1	10	8.92	10.1	25.8
13	27.1	Layered	1	25	8.46	11.4	23.9
14	27.1	Layered	1	35	9.34	11.3	23.9
15	27.1	Blended	1	100	10.08	11.6	28

(continued)

5	Sample	Basis Weight (gsm)	Web Structure	Plies	Bamboo Total Web (wt%)	Tear Index	Stiffness Index	Durability Index
	16	27.1	Blended	1	0	8.1	11.6	20.5
	17	36.5	NA	1	0	11.2	6.0	27.1
10	18	36.5	Layered	1	40	13.3	5.3	33.5
	19	36.5	Layered	1	0	12.0	4.9	31.9
	20	36.5	NA	1	0	12.0	6.6	29.2
	21	36.5	Layered	1	50	13.3	5.3	34.9
15	22	36.5	Layered	1	40	13.6	5.8	33.6
	23	36.5	Layered	1	0	13.4	4.8	34.2
	24	36.5	Layered	1	0	14.7	4.9	37.4
20	25	36.5	Layered	1	40	13.0	5.5	33.9
	26	39.0	Blended	1	0	10.9	4.7	31.8
	27	39.0	Blended	1	70	10.1	7.5	31.6

25 **[0123]** The relative change in the Durability Index and Stiffness Index, compared to an identical control containing NBSK in place of bamboo, is summarized in the table below.

TABLE 9

30	Sample	Single Ply Basis Weight (gsm)	Web Structure	Plies	Method of Manufacture	Bamboo Total Web (wt%)	Delta Durability Index (%)	Delta Stiffness Index (%)
	3	15.1	Layered	2	CWP	30	-20.1%	32.6%
	4	15.1	Layered	2	CWP	40	-12.9%	30.2%
35	9	16.7	Blended	1	CWP	40	-31.7%	31.6%
	10	16.7	Blended	1	CWP	40	-17.6%	43.0%
	12	27.1	Layered	1	UCTAD	10	0.6%	0.4%
40	13	27.1	Layered	1	UCTAD	25	-6.5%	-2.2%
	14	27.1	Layered	1	UCTAD	35	-6.7%	10.4%
	15	27.1	Blended	1	UCTAD	100	9.2%	9.9%
	18	36.5	Layered	1	UCTAD	40	5.1%	7.1%
45	21	36.5	Layered	1	UCTAD	50	2.0%	11.1%
	22	36.5	Layered	1	UCTAD	40	-1.6%	20.4%
	25	36.5	Layered	1	UCTAD	40	-9.3%	12.2%
50	27	39.0	Blended	1	UCTAD	70	-0.4%	61.4%

55 **[0124]** While tissue webs and products comprising the same have been described in detail with respect to the specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing, may readily conceive of alterations to, variations of, and equivalents to these embodiments. Accordingly, the scope of the present invention should be assessed as that of the appended claims.

Claims

1. A layered through-air dried tissue web, the web comprising a first fibrous layer and a second fibrous layer, the first fibrous layer comprising wood fibers and the second layer comprising bamboo fibers, wherein the first fibrous layer is substantially free of bamboo fibers and wherein the bamboo fibers comprise at least 10 percent of the total weight of the through-air dried web.
2. The layered through-air dried tissue web of claim 1 wherein the first fibrous layer consists essentially of hardwood fibers and the second fibrous layer comprises bamboo and softwood fibers, wherein the amount of softwood fiber in the second fibrous layer is less than 10 percent by weight of the layer.
3. The layered through-air dried tissue web of claim 1 wherein the first fibrous layer comprises at least 75 percent hardwood fibers by weight of the first fibrous layer and the second layer comprises at least 50 percent bamboo fibers by weight of the second fibrous layer.
4. The layered through-air dried tissue web of claim 1 wherein the through-air dried web comprises less than 10 percent softwood fibers by weight of the through-air dried web.
5. The layered through-air dried tissue web of claim 1 having a Stiffness Index less than 7.
6. The layered through-air dried tissue web of claim 1 having a Bulk greater than 10 cubic centimeters per gram.
7. A tissue product comprising the through-air dried tissue web of any preceding claim, having from 10 percent to 80 percent bamboo fibers by weight of the through-air dried tissue web.
8. A tissue product comprising the through-air dried tissue web of any of claims 1-6, the tissue product having a basis weight between 10 to 60 gsm.
9. The tissue product of claim 7 or 8 further comprising a second tissue web plied to the first through-air dried tissue web.

Patentansprüche

1. In Lagen angeordnete, durchluftgetrocknete Tissuebahn, wobei die Bahn eine erste Faserlage und eine zweite Faserlage umfasst, wobei die erste Faserlage Holzfasern umfasst und die zweite Lage Bambusfasern umfasst, wobei die erste Faserlage im Wesentlichen frei von Bambusfasern ist und wobei die Bambusfasern mindestens 10 Prozent des Gesamtgewichts der durchluftgetrockneten Bahn umfassen.
2. In Lagen angeordnete, durchluftgetrocknete Tissuebahn nach Anspruch 1, wobei die erste Faserlage im Wesentlichen aus Hartholzfasern besteht und die zweite Faserbahn im Wesentlichen Bambus- und Weichholzfasern umfasst, wobei der Anteil der Weichholzfasern in der zweiten Faserbahn weniger als 10 Gewichtsprozent der Lage ist.
3. In Lagen angeordnete, durchluftgetrocknete Tissuebahn nach Anspruch 1, wobei die erste Faserlage Hartholzfasern von mindestens 75 Gewichtsprozent der ersten Faserlage umfasst und die zweite Lage Bambusfasern von mindestens 50 Gewichtsprozent der zweiten Faserlage umfasst.
4. In Lagen angeordnete, durchluftgetrocknete Tissuebahn nach Anspruch 1, wobei die durchluftgetrocknete Bahn Weichholzfasern von mindestens 10 Gewichtsprozent der durchluftgetrockneten Bahn umfasst.
5. In Lagen angeordnete, durchluftgetrocknete Tissuebahn nach Anspruch 1, die einen Steifigkeitsindex kleiner als 7 aufweist.
6. In Lagen angeordnete, durchluftgetrocknete Tissuebahn nach Anspruch 1, die ein Volumen größer als 10 Kubikmeter pro Gramm aufweist.
7. Tissueprodukt, umfassend die durchluftgetrocknete Tissuebahn nach einem der vorstehenden Ansprüche, das Bambusfasern von 10 Gewichtsprozent bis 80 Gewichtsprozent der durchluftgetrockneten Tissuebahn aufweist.

8. Tissueprodukt, umfassend die durchluftgetrocknete Tissuebahn nach einem der Ansprüche 1-6, wobei das Tissueprodukt ein Flächengewicht zwischen 10 und 60 g/m² aufweist.
9. Tissueprodukt nach Anspruch 7 oder 8, ferner umfassend eine zweite Tissuebahn, die an die erste durchluftgetrocknete Tissuebahn gedoppelt ist.

Revendications

1. Nappe tissulaire stratifiée séchée à l'air, la nappe comprenant une première et une deuxième couche fibreuse, la première couche fibreuse comprenant des fibres de bois et la deuxième couche comprenant des fibres de bambou, dans laquelle la première couche fibreuse est sensiblement exempte de fibres de bambou et dans laquelle les fibres de bambou représentent au moins 10 % du poids total de la nappe séchée à l'air.
2. Nappe tissulaire stratifiée séchée à l'air selon la revendication 1, dans laquelle la première couche fibreuse est constituée essentiellement de fibres de bois dur et la deuxième couche fibreuse comprend des fibres de bambou et de bois tendre, la quantité de fibres de bois tendre dans la deuxième couche fibreuse étant inférieure à 10 % en poids de la couche.
3. Nappe tissulaire stratifiée séchée à l'air selon la revendication 1, dans laquelle la première couche fibreuse est constituée d'au moins 75 % en poids de fibres de bois dur de la première couche fibreuse et la deuxième couche est constituée d'au moins 50 % en poids de fibres de bambou de la deuxième couche fibreuse.
4. Nappe tissulaire stratifiée séchée à l'air selon la revendication 1, dans laquelle la nappe séchée à l'air est constituée d'au moins 10 % de fibres de bois résineux en poids de la nappe séchée à l'air.
5. Nappe tissulaire stratifiée séchée à l'air selon la revendication 1, ayant un indice de rigidité inférieur à 7.
6. Nappe tissulaire stratifiée séchée à l'air selon la revendication 1, ayant une masse supérieure à 10 centimètres cubes par gramme.
7. Produit en tissu comprenant la nappe de tissu séchée à l'air selon toute revendication précédente, ayant de 10 % à 80 % de fibres de bambou en poids de la nappe de tissu séchée à l'air.
8. Produit en tissu comprenant la nappe de tissu séchée à l'air selon l'une quelconque des revendications 1 à 6, le produit en tissu ayant un poids de base compris entre 10 et 60 g/m².
9. Produit en tissu selon la revendication 7 ou 8 comprenant en outre une deuxième nappe de tissu pliée sur la première nappe de tissu séchée à l'air.

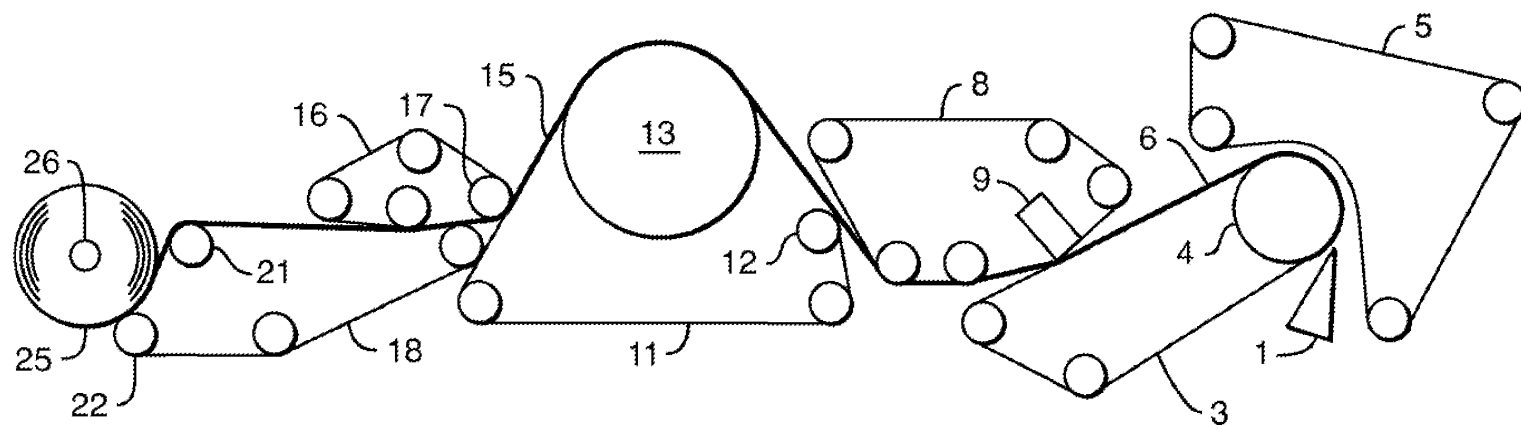


FIG. 1

REFERENCES CITED IN THE DESCRIPTION

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
07/02/2025 11:22:58 AM Z ET

ATTORNEY DOCKET #
16255M3

Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 7685

FILED BY Tamara Gozdiff

PATENT CENTER # 71185630

FILING DATE 04/06/2023

CUSTOMER # 27752

FIRST NAMED INVENTOR Christopher Michael YOUNG

CORRESPONDENCE ADDRESS -

AUTHORIZED BY Richard Alexander

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
16255M3 Applicant_Initiated_Interview _Request_Form_cbc.pdf	3	First Action Interview - Schedule Interview request	268 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
16255M3 Applicant_Initiated_Interview_R equest_Form_cbc.pdf	9A458B696289439E9F9C27B5A04BC5A62B8BC34125F6233820 EB8A4EEA46C255D5871870C5A9539E3BA087D2C327B05154F 59741896C401521E12D7733CFF008

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Applicant Initiated Interview Request Form

Application No.: 18/131,383 First Named Applicant: CHRISTOPHER MICHAEL YOUNG
 Examiner: JOSE A FORTUNA Art Unit: 1748 Status of Application: PENDING

Tentative Participants:

(1) C. BRANT COOK (2) _____
 (3) _____ (4) _____

Proposed Date of Interview: JULY 2, 2025 Proposed Time: 2:00 (☉AM☉PM)

Type of Interview Requested:

(1) ☒ Telephonic (2) ☐ Personal (3) ☐ Video Conference

Exhibit To Be Shown or Demonstrated: ☐ YES ☐ NO

If yes, provide brief description: _____

Issues To Be Discussed

Issues (Rej., Obj., etc)	Claims/ Fig. #s	Prior Art	Discussed	Agreed	Not Agreed
(1) <u>103</u>	<u>1-14</u>	<u>SHANNON, SEGER, REKOSKE</u>	☐	☐	☐
(2) _____	_____	_____	☐	☐	☐
(3) _____	_____	_____	☐	☐	☐
(4) _____	_____	_____	☐	☐	☐

☐ Continuation Sheet Attached ☐ Proposed Amendment or Arguments Attached

Brief Description of Arguments to be Presented:

SHANNON TEACHES BAMBOO IN NON-CONSUMER-FACING SURFACE

An interview was conducted on the above-identified application on JULY 2, 2025

NOTE: This form should be completed and filed by applicant in advance of the interview (see MPEP § 713.01). If this form is signed by a registered practitioner not of record, the Office will accept this as an indication that he or she is authorized to conduct an interview on behalf of the principal (37 CFR 1.32(a)(3)) pursuant to 37 CFR 1.34. This is not a power of attorney to any above named practitioner. See the Instruction Sheet for this form, which is incorporated by reference. By signing this form, applicant or practitioner is certifying that he or she has read the Instruction Sheet. After the interview is conducted, applicant is advised to file a statement of the substance of this interview (37 CFR 1.133(b)) as soon as possible. This application will not be delayed from issue because of applicant's failure to submit a written record of this interview.

/C. BRANT COOK/

Applicant/Applicant's Representative Signature

Examiner/SPE Signature

C. BRANT COOK

Typed/Printed Name of Applicant or Representative

513-307-8268

Applicant's/Applicant's Representative's Telephone Number

39,151

Registration Number, if applicable

This collection of information is required by 37 CFR 1.133. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 24 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Instruction Sheet for:
APPLICANT INITIATED INTERVIEW REQUEST FORM
(Not to be Submitted to the USPTO)

1. If this form is signed by a registered practitioner not of record, the authority to submit the Applicant Initiated Interview Request Form is pursuant to limited authority to act in a representative capacity under 37 CFR 1.34 and further proof of authority to act in a representative capacity may be required. See 37 CFR 1.34.

The Office will accept the signed form as an indication that the registered practitioner not of record is authorized to conduct an interview on behalf of the principal in pursuant to 37 CFR 1.34.

For more information, see the "Conducting an Interview with a Registered Practitioner Acting in a Representative Capacity" notice which is available on the USPTO Web site at: <http://www.uspto.gov/patents/law/notices/2010.jsp>.

2. This is not a power of attorney to any named practitioner. Accordingly, any registered practitioner not of record named on the form does not have authority to sign a request to change the correspondence address, a request for express abandonment, a disclaimer, a power of attorney, or other document requiring the signature of the applicant, assignee of the entire interest or an attorney of record. If appropriate, a separate power of attorney to the named practitioner should be executed and filed in the US Patent and Trademark Office.
3. Any interview concerning an unpublished application under 35 U.S.C. § 122(b) with a registered practitioner not of record who obtains authorization through use of the PTOL-413A will be conducted based on the information and files supplied by the practitioner in view of the confidentiality requirements of 35 U.S.C. § 122(a).

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	18/131,383
Filing Date	April 6, 2023
First Named Inventor	Christopher Michael YOUNG
Title	Soft Sanitary Tissue Products Comprising Non-wood Fibers
Art Unit	1748
Examiner Name	Jose A. Fortuna
Attorney Docket Number	16255M3

SIGNATURE of Applicant or Patent Practitioner

Signature	/RLA/	Date (Optional)	
Name	Richard L. Alexander	Registration Number	52,463
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)	The Procter & Gamble Company		
<p>NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.</p>			
<p>☒ *Total of <u>1</u> forms are submitted.</p>			

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☐ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

OR

☒ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

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I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

The Procter & Gamble Company

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☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature /Jay A Krebs/

Date (Optional) 01/02/2025

Name Jay A. Krebs

Title Director and Assistant Secretary - Oral Care Patents, North America, The Procter & Gamble Company

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

POWER OF ATTORNEY BY APPLICANT

No more than ten (10) patent practitioners total may be appointed as set forth below by name and registration number. This page need not be submitted if appointing the Patent Practitioner(s) associated with a Customer Number (see form PTO/AIA/82B):

Name	Registration Number
Richard L. Alexander	52,463
C. Brant Cook	39,151

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



UNITED STATES
PATENT AND TRADEMARK OFFICE

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
07/02/2025 01:01:38 PM Z ET

ATTORNEY DOCKET #
16255M3

Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 7685

FILED BY Tamara Gozdiff

PATENT CENTER # 71188466

FILING DATE 04/06/2023

CUSTOMER # 27752

FIRST NAMED INVENTOR Christopher Michael YOUNG

CORRESPONDENCE ADDRESS -

AUTHORIZED BY Richard Alexander

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
16255M3- Power_of_Attorney_and_Tra nsmittal-Cook.pdf	4	Power of Attorney	192 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
16255M3- Power_of_Attorney_and_Trans mittal-Cook.pdf	6436F7BA5AC6A74D2ADD098D069D46DA0B677941C95F297A B5FAC96532DEF882ED91F4CA69FDF103FF32C7A8BE7B0E73 E95CF46309621B339E84B2BC89ED6840

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

**Kimberly Clark EX1002, p. 4504
PGR2026-00078**

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
18/131,383	04/06/2023	Christopher Michael YOUNG	16255M3

CONFIRMATION NO. 7685

POWER OF ATTORNEY NOTICE



OC000000091154088

27752

THE PROCTER & GAMBLE COMPANY
GLOBAL IP SERVICES
CENTRAL BUILDING, C9
ONE PROCTER AND GAMBLE PLAZA
CINCINNATI, OH 45202

Date Mailed: 07/08/2025

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/02/2025.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/atesfai/



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
18/131,383	04/06/2023	Christopher Michael YOUNG	16255M3

CONFIRMATION NO. 7685

POA ACCEPTANCE LETTER



OC000000091154132

27752

THE PROCTER & GAMBLE COMPANY
GLOBAL IP SERVICES
CENTRAL BUILDING, C9
ONE PROCTER AND GAMBLE PLAZA
CINCINNATI, OH 45202

Date Mailed: 07/08/2025

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/02/2025.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/atesfai/

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 18/131,383		Filing Date 04/06/2023		☐ To be Mailed					
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO													
APPLICATION AS FILED - PART I													
		(Column 1)		(Column 2)									
FOR		NUMBER FILED		NUMBER EXTRA		RATE (\$)		FEE (\$)					
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A		N/A		N/A							
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))		N/A		N/A		N/A							
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A		N/A		N/A							
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =		*		x \$100 =							
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =		*		x \$ 480 =							
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).											
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))													
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL							
APPLICATION AS AMENDED - PART II													
		(Column 1)		(Column 2)		(Column 3)							
AMENDMENT	07/16/2025		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)		
	Total (37 CFR 1.16(i))		* 21		Minus ** 21		= 0		x \$ 200 =		0		
	Independent (37 CFR 1.16(h))		* 5		Minus *** 5		= 0		x \$ 600 =		0		
	☐ Application Size Fee (37 CFR 1.16(s))												
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))												
										TOTAL ADD'L FEE		0	
		(Column 1)		(Column 2)		(Column 3)							
AMENDMENT			CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)		
	Total (37 CFR 1.16(i))		*		Minus **		=		x \$ 0 =				
	Independent (37 CFR 1.16(h))		*		Minus ***		=		x \$ 0 =				
	☐ Application Size Fee (37 CFR 1.16(s))												
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))												
										TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.										SLIE			
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".										/DESHONNE T. MARTINO-RAY/			
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".													
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.													

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
07/16/2025 10:24:01 AM Z ET

ATTORNEY DOCKET #
16255M3

Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 7685

FILED BY Bonnie Combs

PATENT CENTER # 71390935

FILING DATE 04/06/2023

CUSTOMER # 27752

FIRST NAMED INVENTOR Christopher Michael YOUNG

CORRESPONDENCE ADDRESS -

AUTHORIZED BY Richard Alexander

Documents

TOTAL DOCUMENTS: 4

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
16255M3-Amend-filed-07-16-25.pdf	8	-	109 KB
16255M3-Amend-filed-07-16-25-A....pdf (1-1)	1	Amendment/Request for Reconsideration-After Non-Final Rejection	93 KB
16255M3-Amend-filed-07-16-25-CLM.pdf (2-5)	4	Claims	78 KB
16255M3-Amend-filed-07-16-25-REM.pdf (6-7)	2	Applicant Arguments/Remarks Made in an Amendment	76 KB
16255M3-Amend-filed-07-16-25-ABST.pdf (8-8)	1	Abstract	72 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
16255M3-Amend-filed-07-16-25.pdf	D788A060EF9DFD7A686A17B1315B87E7D09E700CE943A564555AA6FDEE8ABD2C3720082D389B212184D8CC86E5042647DE0AA5462718EE8844D076D7FA17663F
16255M3-Amend-filed-07-16-25-A....pdf	2C8755DC62AF8A9D418AD1DB99769DFA4641479764BABCC450134B44FA37B191B1D2EB71EFE6B7F3B7DB84EC38522549EECA2C1FC4C46BAC1E1A929FFEEAA773
16255M3-Amend-filed-07-16-25-CLM.pdf	84B48C8D2500AB534D31DC86309FAE7D183D8F8363E11174F1B3E1EF373958FF03609C43174B4E762C186DBC3D07C24C93BAFE7C7981983306A47A48615C05F
16255M3-Amend-filed-07-16-25-REM.pdf	1C636AC4853C9E917C6299A38597634987D673F9BB723DFD059E9B4C5C0A6C6EC0F757DDE4A612C5DFF71798542528CBA0733F96FACE27BA4EE12D7A1B96755B
16255M3-Amend-filed-07-16-25-ABST.pdf	CC892A366FE102F6193DDDBEB876B756E2BBCE505B7A6194A58CB678C550CA3CE0C1F19EB0BE2904466BC44B05663525A4313EBEBE2263524BF56FF90867929A

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 18/131,383
Inventors : Christopher Michael YOUNG et al.
Filed : April 6, 2023
Art Unit : 1748
Examiner : JOSE A FORTUNA
Docket No. : 16255M3
Confirmation No. : 7685
Customer No. : 27752
Title : Soft Sanitary Tissue Products Comprising Non-wood Fibers

AMENDMENT TO NON-FINAL OFFICE ACTION

The Director is hereby authorized to charge all required fees (including any extension of time fees) and to credit any overpayments in this and any concurrent or future correspondence to Deposit Account No. 16-2480.

In response to the Non-Final Office Action dated April 16, 2025 (the “Office Action”), in the above-identified application (the “Subject Application”), please consider the following amendments and remarks and reconsider the Subject Application.

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims begin on page 3 of this paper.

Remarks begin on page 6 of this paper.

Appl. No. 18/131,383 2
Docket No. 16255M3
Reply to Office Action mailed on April 16, 2025
Customer No. 27752

AMENDMENTS TO THE SPECIFICATION

Please amend the Specification to include a replacement Abstract.

Submitted herewith: Replacement Abstract on a separate page.

AMENDMENTS TO THE CLAIMS

This Listing of the Claims replaces all claim sets in the Subject Application.

Listing of the Claims:

1. (Currently Amended) A multi-ply sanitary tissue product, comprising:
at least about 5% to about 100% by weight non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof;
wherein the multi-ply sanitary tissue product comprises a consumer-facing surface comprising at least a portion of the non-wood fibers; and
wherein the multi-ply sanitary tissue product exhibits a TS7 of less than about 14 dB V² rms.
2. (Currently Amended) The multi-ply sanitary tissue product of claim 1, wherein the non-wood fibers consist of bamboo fibers.
3. (Currently Amended) The multi-ply sanitary tissue product of claim 1, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.
4. (Currently Amended) The multi-ply sanitary tissue product of claim 1, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the comprising non-wood fibers greater than about 30%.
5. (Currently Amended) A multi-ply sanitary tissue product, comprising:
at least about 5% to about 100% by weight bamboo fibers;
wherein the multi-ply sanitary tissue product comprises a consumer-facing surface comprising at least a portion of the bamboo fibers; and
wherein the multi-ply sanitary tissue product exhibits a TS750 less than about ~~4520~~
dB V² rms.

6. (Currently Amended) The multi-ply sanitary tissue product of claim 5, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.

7. (Currently Amended) The multi-ply sanitary tissue product of claim 5, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the bamboo fibers~~are greater than about 30% of the sanitary tissue product~~.

8. (Currently Amended) The multi-ply sanitary tissue product of claim 5, wherein the multi-ply sanitary tissue product comprises greater than about 75% to about 100% by weight of the bamboo fibers~~are greater than about 75% of the sanitary tissue product~~.

9. (Currently Amended) A multi-ply~~structured~~ sanitary tissue product, comprising:
at least about 5% to about 100% by weight non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof;
wherein the multi-ply sanitary tissue product comprises a consumer-facing surface comprising at least a portion of the non-wood fibers; and
wherein the multi-ply sanitary tissue product exhibits a TS750 less than about 45 dB V² rms.

10. (Currently Amended) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product comprises a structured fibrous structure~~non-wood fibers consist of bamboo fibers~~.

11. (Currently Amended) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.

12. (Currently Amended) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the~~comprising non-wood fibers~~greater than about 30%.

13. (Currently Amended) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product exhibits a TS750 of less than 40 dB V² rms.

14. (Currently Amended) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product exhibits a TS750 of from about 25 to about 35 dB V² rms.

15. (Withdrawn) A sanitary tissue product, comprising:
non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof; and
a slip stick less than about 435.

16. (Withdrawn) The sanitary tissue product of claim 15, wherein the non-wood fibers consist of bamboo fibers.

17. (Withdrawn) The sanitary tissue product of claim 15, wherein the slip stick is from about 235 to about 435.

18. (Withdrawn) A structured sanitary tissue product, comprising:
non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof; and
a slip stick less than about 605.

19. (Withdrawn) The sanitary tissue product of claim 18, wherein the slip stick is from about 235 to about 605.

20. (Withdrawn) The sanitary tissue product of claim 18, wherein the slip stick is from about 350 to about 500.

21. (Withdrawn) The sanitary tissue product of claim 18, wherein the sanitary tissue product comprises a through-air-dried (TAD) and uncreped web.

REMARKS

Claim Status

Claims 1-21 are pending in the present application. Claims 15-21 have been withdrawn as a result of an earlier restriction requirement. Claims 1, 5, and 9 have been amended to define the claimed invention with greater specificity by reciting a multi-ply sanitary tissue product having a consumer-facing surface comprising non-wood fibers. Support for these amendments is found throughout the Specification, for example, at page 29, lines 7-19, at page 30, lines 6-10, and at page 55, lines 23-26 and/or Claims as originally filed. Claims 2-4, 6-8, and 10-14 have been amended to be consistent with Claims 1, 5, and 9, as amended, respectively. Support for these amendments is found throughout the Specification and/or Claims as originally filed.

The Specification has been amended to replace the Abstract with a new Replacement Abstract.

Specification Objections

The Specification has been amended to include a Replacement Abstract to overcome the objection.

Rejection under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph

Claims 1-14 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.

Applicant respectfully submits that Claims 1, 5, and 9, as amended, are definite. Further, Applicant respectfully submits that Claims 2-4, 6-8, and 10-14, as amended, which ultimately depend from Claims 1, 5, and 9, as amended, respectively, are definite. Accordingly, Applicant respectfully requests withdrawal of this rejection.

Rejection under 35 U.S.C. 103 over Shannon as evidenced by Seger, and in view of Rekoske

Claims 1-14 are rejected under 35 U.S.C. 103 as allegedly being unpatentable over U.S. Pub. No. 2013/0071678 to Shannon (hereafter “Shannon”) as evidenced by U.S. Pub. No.

2021/0017710 to Seger et al., (hereafter “Seger”), and in view of U.S. Patent No. 9,657,443 to Rekoske et al. (hereafter “Rekoske”).

Applicant respectfully submits that Shannon as evidenced by Seger, and in view of Rekoske fails to teach each and every element of Claims 1, 5, and 9, the independent claims, as amended, because Shannon as evidenced by Seger, and in view of Rekoske, fails to teach, at a minimum, a multi-ply sanitary tissue product comprising a consumer-facing surface comprising non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof. Applicant respectfully submits that Shannon teaches away from a multi-ply sanitary tissue product comprising a consumer-facing surface comprising non-wood fibers. Shannon, Paragraphs [0010] and [0051] and Examples. Seger fails to overcome the deficiencies of Shannon. Further, Applicant respectfully submits that Rekoske fails to overcome the deficiencies of Shannon since Rekoske, at a minimum, fails to teach or suggest non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof. Accordingly, Applicant respectfully submits that Claims 1, 5, and 9, as amended, are not rendered obvious over Shannon as evidenced by Seger, and in view of Rekoske. MPEP 2143.03. Further, Applicant respectfully submits that Claims 2-4, 6-8, and 10-14, as amended, which ultimately depend from Claims 1, 5, and 9, as amended, respectively, are not rendered obvious over Shannon as evidenced by Seger, and in view of Rekoske. MPEP 2143.03.

Conclusion

This response represents an earnest effort to place the present application in proper form and to distinguish the invention as claimed from the applied reference(s). In view of the foregoing, entry of the amendment(s) presented herein, reconsideration of this application, and allowance of the pending claim(s) are respectfully requested.

Respectfully submitted,

THE PROCTER & GAMBLE COMPANY

By /RLA/
Richard L. Alexander
Registration No. 52,463
(513) 983-7631

Date: July 16, 2025
Customer No. 27752

Appl. No. 18/131,383 8
Docket No. 16255M3
Reply to Office Action mailed on April 16, 2025
Customer No. 27752

ABSTRACT

Sanitary tissue products having non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof and exhibiting a TS7 of less than about 14 dB V² rms and/or a TS750 less than about 45 dB V² rms.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 18/131,383
Inventor(s) : Christopher Michael YOUNG et al.
Filed : 04/06/2023
Art Unit : 1748
Examiner : JOSE A FORTUNA
Docket No. : 16255M3
Confirmation No. : 7685
Customer No. : 27752
Title : SOFT SANITARY TISSUE PRODUCTS
COMPRISING NON-WOOD FIBERS

INFORMATION DISCLOSURE STATEMENT

Pursuant to 37 C.F.R. §§ 1.56, 1.97 and 1.98, it is respectfully requested that the document(s) cited in this submission be carefully considered by the Examiner and made of record in this case. As provided in §1.97(g), no representation is made or intended that a thorough art search was made. As provided in 37 C.F.R. §1.97(h), this Information Disclosure Statement does not constitute an admission of any kind, and specifically is not an admission that the document(s) cited in this submission is (are), or is (are) considered to be, material to the patentability of the above-identified patent application, as defined in 37 C.F.R. §1.56(b).

This Information Disclosure Statement is being submitted under 37 C.F.R. §1.97(c). I hereby elect to pay the fee set forth in 37 C.F.R. §1.17(p). Authorization is hereby given to charge the fee set forth in 37 C.F.R. §1.17(p) to Deposit Account Number 16-2480 in the name of The Procter & Gamble Company.

Information Disclosure Size Fee:

☒ Applicant or patent owner certifies that no IDS size fee is required under § 1.17(v) for this submission.

☐ Applicant or patent owner certifies that the IDS is accompanied by the IDS size fee of \$200 in accordance with § 1.17(v)(1) for a cumulative number of applicant-provided

Appl. No. 18/131,383
Docket No. 16255M3
Customer No. 27752

2

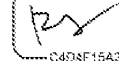
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☐ Applicant or patent owner certifies that the IDS is accompanied by the IDS size fee of \$500 in accordance with § 1.17(v)(2) for a cumulative number of applicant-provided or patent owner-provided items of information submitted to date including those in the accompanying IDS in excess of 100, but not exceeding 200 (less any amount previously paid under § 1.17(v)(1)). The Director is authorized to charge the fee under § 1.17(v)(2) for this IDS submission to deposit account 16-2480.

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Respectfully submitted,

THE PROCTER & GAMBLE COMPANY



C4D8F15A26E7452

Signature

Richard L. Alexander
Registration No. 52,463
(513) 983-7631

Date: July 9, 2025 | 9:43:17 AM EDT
Customer No. 27752

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	18131383
	Filing Date	2023-04-06
	First Named Inventor	YOUNG Christopher Michael (YOUNG/CM)
	Art Unit	1748
	Examiner Name	JOSE A FORTUNA
	Attorney Docket Number	--16255M3-US

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Inventor of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	8343625	B2	2013-01-01	Mackey, Larry Neil et al.	
	2	8715826	B2	2014-05-06	Mackey, Larry Neil et al.	

If you wish to add additional U.S. Patent citation information, please click the Add button.

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Inventor or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Published Application citation information, please click the Add button.

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Examiner Initial*	Cite No	Foreign Document Number	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							☐

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NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	18131383
	Filing Date	2023-04-06
	First Named Inventor	YOUNG Christopher Michael (YOUNG/CM)
	Art Unit	1748
	Examiner Name	JOSE A FORTUNA
	Attorney Docket Number	--16255M3-US

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1		☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	
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*EXAMINER: Initial if reference considered and whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
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UNITED STATES
PATENT AND TRADEMARK OFFICE

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
07/17/2025 02:05:21 PM Z ET

ATTORNEY DOCKET #
16255M3

Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 7685

FILED BY Gaurav Kumar

PATENT CENTER # 71407598

FILING DATE 04/06/2023

CUSTOMER # 27752

FIRST NAMED INVENTOR Christopher Michael YOUNG

CORRESPONDENCE ADDRESS -

AUTHORIZED BY Richard Alexander

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
16255M3-US_IDSLetter_23Jun2025.pdf	2	Transmittal Letter	144 KB
16255M3-US_Listofrefrencescited_23Jun2025.pdf	3	Information Disclosure Statement (IDS) Form (SB08)	166 KB

Warning: The PDF file has been signed with a digital signature and the legal effect of the document will be based on the contents of the file not the digital signature. This is not a USPTO supplied IDS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.

Digest

DOCUMENT**MESSAGE DIGEST(SHA-512)**

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US_IDSLetter_23Jun2025.pdf

B603944EE8F026A9FD1113E6D15B3E22713FE16FC814995208
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16255M3-
US_Listofrefrencescited_23Jun
2025.pdf

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If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



UNITED STATES
PATENT AND TRADEMARK OFFICE

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
07/17/2025 02:05:21 PM Z ET

ATTORNEY DOCKET #
16255M3

Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 7685

FILED BY Gaurav Kumar

PATENT CENTER # 71407598

AUTHORIZED BY Richard Alexander

CUSTOMER # 27752

FILING DATE 04/06/2023

CORRESPONDENCE ADDRESS -

FIRST NAMED INVENTOR Christopher Michael YOUNG

Payment Information

PAYMENT METHOD
DA / 162480

PAYMENT TRANSACTION ID
E20257GE05466717

PAYMENT AUTHORIZED BY
Gaurav Kumar

FEE CODE	DESCRIPTION	ITEM PRICE(\$)	QUANTITY	ITEM TOTAL(\$)
1806	SUBMISSION OF AN INFORMATION DISCLOSURE STATEMENT	280.00	1	280.00
TOTAL AMOUNT:				\$280.00

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C.

**Kimberly Clark EX1002, p. 4526
PGR2026-00078**

371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/131,383	04/06/2023	Christopher Michael YOUNG	16255M3	7685
27752 7590 07/23/2025 THE PROCTER & GAMBLE COMPANY GLOBAL IP SERVICES CENTRAL BUILDING, C9 ONE PROCTER AND GAMBLE PLAZA CINCINNATI, OH 45202			EXAMINER FORTUNA, JOSE A	
			ART UNIT 1748	PAPER NUMBER
			NOTIFICATION DATE 07/23/2025	DELIVERY MODE ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

centraldocket.im@pg.com
mayer.jk@pg.com
pair_pg@firsttofile.com

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis (i.e., changing from AIA to pre-AIA) for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly

owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

Claims 1-14 are rejected under 35 U.S.C. 103 as being unpatentable over Kleinwaechter et al., (hereinafter Kleinwaechter), US Patent Application Publication No. 2019/0366676 A1 in view of Rouse et al., (hereinafter Rouse), WO 2018/156109 A1 as evidenced by or in view of Rekoske et al., (hereinafter Rekoske), United State Patent No. 9,657,443 B2

With regard to claims 1, 3 5-6, 9, 11 and 13-14, Kleinwaechter teaches a sanitary tissue comprising non-wood fibers ; see ¶-[0087] and [0012] which teaches that the tissue is structured and can be multi-ply tissues. While Kleinwaechter does not explicitly teach that the outer surface of the tissue contains the non-wood fibers, i.e., the surface(s) contacting the consumer face, the secondary reference teaches tissues in which the non-wood fibers are deposited on/in the outer surface of the tissue, and said tissues can be multi-ply in which the plies are joined such that the surface brought into contact with the user's skin in-use comprises non-wood cellulosic fiber; see abstract and page 11, lines 3-13 and the non-wood fibers are added at ranges falling within the claimed range; see page 8, lines 18-25. Rouse teaches the advantages of using such fibers in the outer surface of the web; see page 8, lines 2-17, which teaches that using the non-wood fibers in the outer surface improves the ratio of the MD/CD ratio can be reduced. Therefore, forming the web including the non-wood fibers in the outer layer/surface, the consumer-facing surface, as suggested by Rouse in the tissue taught by Kleinwaechter, would have been obvious to one of ordinary skill in the art in order to obtain the advantages(s) discussed above. Note also the one of

ordinary skill in the art would have reasonable expectation of success if the non-wood fibers were added to the outer surface of the web, since that is known in the art and one of the possible distribution of the fibers, i.e., one can added to the surface or internally, and it has been held that it is obvious to try, choosing from a finite number of identified, predictable solutions with a reasonable expectation of success. See recent Board decision *Ex parte Smith*, --USPQ2d--, slip op. at 20, (Bd. Pat. App. & Interf. June 25, 2007) (Citing KSR, 82 USPQ2d at 1396).

As to the softness and smoothness, TS7 and TS750 respectively, as claimed, those properties must be inherent to the tissues of combination of references, i.e., Kleinwaechter and Rouse, since they contain the same type of non-wood fibers, e.g., bamboo, and are made using the same process, e.g., TAD process, as disclosed in the current application. Moreover, Rekoske teaches the same type of tissues that can contain non-wood fibers and have TS7 and TS750 in the claimed range; see for example column 7, lines 32- 42 (for the non-wood), abstract, tables 1 and 7 and claims, for the TS7 and the TS750. Also Rekoske shows that commonly-known tissues have TS7 and TS750 falling within the claimed range; see table 1 for facial tissues and table 7 for other type of tissues/towels, which clearly indicates that the tissues of the primary reference would have the same softness and smoothness properties or at the very least processing the tissues as suggested by Rekoske, would have been obvious to one of ordinary skill in the art.

Regarding to claim 2, both Kleinwaechter and Rouse teach the use of the same type of non-wood fibers, including bamboo fibers; see ¶-[0080]-[0085] of Kleinwaechter and page 9, lines 3-13 of Rouse.

With regard to claim 10, Both, Kleinwaechter and Rouse, teach the through-air-drying (TAD) process in the making of the tissue; see ¶-[0088] of Kleinwaechter and page 12, lines 18-

27 and 13: lines 15-23 of Rouse. Note that structured is inherent to the TAD process¹. However, Kleinwaechter teaches that the sanitary product is structured; see ¶-[0126]-[0127].

Regarding to claims 4, 7-8, 12 Rouse teaches amounts of at least 5% which includes the claimed range, since at least 5% includes ranges up to 100%.

Response to Arguments

Applicant's arguments with respect to claim(s) 1-14of have been considered but are moot because of the new ground of rejection.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure "Sanitary Tissue Products Comprising Non-wood Fibers and Having Improved Formation."

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period

¹ This evidenced by Seger, previously cited; see for example that abstract, ¶- [0002], [0014], etc.

will expire on the date the advisory action is mailed, and any nonprovisional extension fee (37 CFR 1.17(a)) pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSE A FORTUNA whose telephone number is (571)272-1188. The examiner can normally be reached MONDAY- FRIDAY 11:30 PM- 9:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Abbas Rashid can be reached on 571-270-7457. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: <https://patentcenter.uspto.gov>. Visit <https://www.uspto.gov/patents/apply/patent-center> for more information about Patent Center and <https://www.uspto.gov/patents/docx> for information about

Application/Control Number: 18/131,383

Page 7

Art Unit: 1748

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Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JOSE A FORTUNA/

Primary Examiner, Art Unit 1748

JAF

<i>Notice of References Cited</i>	Application/Control No. 18/131,383		Applicant(s)/Patent Under Reexamination YOUNG et al.	
	Examiner JOSE A FORTUNA		Art Unit 1748	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
*	A	US-11795619-B2	2023-10-24	Wei; Ning	D21H27/00	1/1
*	B	US-11634870-B2	2023-04-25	Rouse; Kayla Elizabeth	D21F11/04	162/129
*	C	US-11053643-B2	2021-07-06	Rouse; Kayla Elizabeth	D21F11/04	1/1
*	D	US-20200232166-A1	2020-07-23	Rouse; Kayla Elizabeth	D21H11/12	1/1
	E					
	F					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N	WO-2018200501-A1	2018-11-0	WO	WEI NING	D21H11/18
	O	WO-2018156109-A1	2018-08-3	WO	ROUSE KAYLA	D21F11/04
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title, Date, Publisher, Edition or Volume, Pertinent Pages
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 11-2023)

Notice of References Cited

Part of Paper No. 20250721

**Kimberly Clark EX1002, p. 4536
PGR2026-00078**

<i>Index of Claims</i> 	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.
	Examiner JOSE A FORTUNA	Art Unit 1748

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	01/25/2025	04/11/2025	07/21/2025						
	1	÷	✓	✓						
	2	÷	✓	✓						
	3	÷	✓	✓						
	4	÷	✓	✓						
	5	÷	✓	✓						
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	7	÷	✓	✓						
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	9	÷	✓	✓						
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	15	÷	N	N						
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<i>Search Notes</i> 	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.
	Examiner JOSE A FORTUNA	Art Unit 1748

CPC - Searched*		
Symbol	Date	Examiner
D21H 27/005, 11/12, 17/26, 21/10, 21/20, 27/002, 27/004, 27/02, 27/30, 27/40, 27/38	07/21/2025	JAF
A47K 10/16	07/21/2025	JAF

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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Search Notes		
Search Notes	Date	Examiner
Pe2e Search (All Databases)	07/21/2025	JAF
Inventor Search	07/21/2025	JAF
EPO/JPO Search	07/21/2025	JAF
Global Dossier Search	07/21/2025	JAF
Reviewed Related applications: 18,131,(381, 382, 392, 384 and 387)	07/21/2025	JAF
Similarity Search	07/21/2025	JAF

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<i>Search Notes</i> 	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.
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Interference Search			
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number		18131383
	Filing Date		2023-04-06
	First Named Inventor	YOUNG Christopher Michael (YOUNG/CM)	
	Art Unit	1748	
	Examiner Name	JOSE A FORTUNA	
	Attorney Docket Number	--16255M3-US	

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Inventor of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
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PC.1.19.25

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.A.F/

Kimberly Clark EX1002, p. 4540
PGR2026-00078

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	Attorney Docket Number		--16255M3-US

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	Art Unit	1748		
	Examiner Name	JOSE A FORTUNA		
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	Examiner Name	JOSE A FORTUNA
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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	All Office Actions: U.S. Patent Application No. 19/039,908 (Attorney Docket No. 16677M), filed on Jan. 29, 2025; SEE PAIR	☐
	2	Non-Final Office Action; U.S. Patent Application No. 18/131,381 (Attorney Docket No. 16255M), dated Apr. 10, 2025; SEE PAIR	☐
	3	Non-Final Office Action; U.S. Patent Application No. 18/131,382 (Attorney Docket No. 16255M2), dated Apr. 10, 2025; SEE PAIR	☐
	4	Non-Final Office Action; U.S. Patent Application No. 18/131,384 (Attorney Docket No. 16255M4), dated Apr. 10, 2025; SEE PAIR	☐
	5	Non-Final Office Action; U.S. Patent Application No. 18/131,387 (Attorney Docket No. 16255M6), dated Apr. 17, 2025; SEE PAIR	☐
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	7	Non-Final Office Action; U.S. Patent Application No. 18/131,392 (Attorney Docket No. 16255M5), dated Apr. 10, 2025; SEE PAIR	☐
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	9	Non-Final Office Action; U.S. Patent Application No. 18/209,506 (Attorney Docket No. 16297M), dated May 14, 2025; SEE PAIR	☐

* Does not comply with 37 CFR 1.98 since each reference needs to be dated.

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10	Non-Final Office Action; U.S. Patent Application No. 18/209,508 (Attorney Docket No. 16297M2), dated Jan. 17, 2025; SEE PAIR	☐
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12	Notice of Allowance; U.S. Patent Application No. 18/209,508 (Attorney Docket No. 16297M2), dated May 20, 2025; SEE PAIR	☐
13	U.S. Unpublished Patent Application No. 19/039,908 (Attorney Docket No. 16677M), filed on Jan. 29, 2025, to Christopher Michael YOUNG et. al. (See PAIR)	☐

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DZ, EC, EE, EG, ES, FI, GB, GD, GF, 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.

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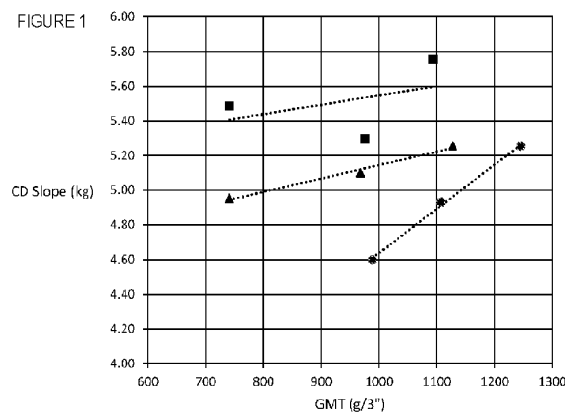
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Published:

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(54) Title: LAYERED TISSUE COMPRISING NON-WOOD FIBERS



(57) Abstract: The present invention provides multi-layered tissue webs, and tissue products comprising the same, the multi-layered webs comprising wood fibers and non-wood cellulosic fibers where the non-wood cellulosic fibers are selectively deposited in one or more outer layers of the multi-layered web. Surprisingly disposing non-wood cellulosic fibers in the outer layers, even in relatively modest amounts, alters the machine and/or cross-machine direction properties of the resulting web, such that MD:CD tensile ratio may be reduced.

WO 2018/156109 A1

LAYERED TISSUE COMPRISING NON-WOOD FIBERS

BACKGROUND OF THE DISCLOSURE

Papermakers, and in particular tissue paper makers, have long sought to balance the strength and softness of paper products by treating or altering the papermaking furnish. For example, one
5 common practice in the manufacture of tissue products is to provide two furnishes (or sources) of wood pulp fiber. Sometimes, a two-furnish system is used in which the first furnish comprises a wood pulp fiber having a relatively short fiber length, such as a hardwood kraft pulp fiber, and the second furnish is made of wood pulp fiber having a relatively long fiber length, such as softwood kraft pulp fiber. The short fiber furnish may be used to provide the finished product with a softer handfeel, while the long fiber
10 furnish may be used to provide the finished product with strength.

While surface softness in tissue products is an important attribute, a second element in the overall softness is stiffness. Stiffness can be measured from the tensile slope of stress-strain tensile curve. The lower the slope the lower the stiffness and the better overall softness the product will display. Stiffness and tensile strength are positively correlated, however at a given tensile strength shorter fibers
15 will display a greater stiffness than long fibers. While not wishing to be bound by theory, it is believed that this behavior is due to the higher number of hydrogen bonds required to produce a product of a given tensile strength with short fibers than with long fibers. Thus, easily collapsible, low coarseness long fibers, such as those provided by Northern Softwood Kraft (NSWK) fibers typically supply the best combination of durability and softness in tissue products when those fibers are used in combination with
20 hardwood Kraft fibers such as Eucalyptus hardwood Kraft fibers. While Northern Softwood Kraft Fibers have a higher coarseness than Eucalyptus fibers their small cell wall thickness relative to lumen diameter combined with their long length makes them the ideal candidate for optimizing durability and softness in tissue.

Unfortunately, supply of NSWK is under significant pressure both economically and
25 environmentally. As such, prices of NSWK fibers have escalated significantly creating a need to find alternatives to optimize softness and strength in tissue products. Another type of softwood fiber is Southern Softwood Kraft (SSWK) widely used in fluff pulp containing absorbent products such as diapers, feminine care absorbent products and incontinence products. Unfortunately while not under the same supply and environmental pressures as NSWK, fibers from SSWK are too coarse for tissue
30 products and are unsuitable for making soft tissue products. While having long fiber length, the SSWK fibers have too wide a cell wall width and too narrow a lumen diameter and thus create stiffer, harsher feeling products than NSWK.

The tissue maker who is able to identify fibers having a desirable combination of fiber length and coarseness from fiber blends generally regarded as inferior with respect to average fiber properties may reap significant cost savings and/or product improvements. For example, the tissue maker may wish to make a tissue paper of superior strength without incurring the usual degradation in softness which accompanies higher strength. Alternatively, the papermaker may wish a higher degree of paper surface bonding to reduce the release of free fibers without suffering the usual decrease in softness which accompanies greater bonding of surface fibers. As such, a need currently exists for a tissue product formed from a fiber that will improve durability without negatively affecting other important product properties, such as softness.

SUMMARY OF THE DISCLOSURE

It has now been surprisingly discovered that the short, low-coarseness fiber fraction of the tissue making furnish may be substituted with non-wood fibers and more specifically non-wood cellulosic fibers having an average fiber length from about 1.0 to about 2.0 mm, without negatively affecting important tissue properties such as strength and stiffness. In some instances tissue product properties may actually be improved by substituting short, low-coarseness fiber with non-wood cellulosic fibers. For example, in one embodiment, the present invention provides a soft and durable tissue comprising from about 10 to about 50 percent non-wood cellulosic fiber and having a ratio of machine direction tensile strength (MD Tensile) to cross-machine direction tensile strength (CD Tensile) of less than about 2.0 and a geometric mean tear strength greater than about 12.0 N. Surprisingly, the foregoing properties are comparable or better than those observed in similarly manufactured tissue products consisting essentially of short wood pulp fibers and long, low-coarseness wood pulp fibers.

Accordingly, in one embodiment, the present disclosure provides a multi-layered tissue web comprising a fabric contacting fibrous layer and a non-fabric contacting, also referred to as the air-side layer, fibrous layer, wherein the fabric contacting fibrous layer comprises wood pulp fibers and the non-fabric contacting fibrous layer comprises a blend of non-wood cellulosic fibers and wood pulp fibers. Preferably the fabric contacting layer is substantially free of non-wood cellulosic fibers and the tissue web comprises from about 5 to about 30 weight percent non-wood cellulosic fibers. In a particularly preferred embodiment the fabric contacting fibrous layer comprises softwood kraft fibers and the non-fabric contacting fibrous layer comprises non-wood cellulosic fibers and hardwood kraft fibers.

In yet other embodiments the present disclosure provides a multi-layered tissue web comprising a fabric contacting fibrous layer and a non-fabric contacting fibrous layer, wherein the fabric contacting fibrous layer consists essentially of wood pulp fibers and is substantially free of non-wood cellulosic fibers and the non-fabric contacting fibrous layer comprises from about 5 to about 30 weight percent

non-wood cellulosic fibers, the tissue web having a basis weight greater than about 20 grams per square meter (gsm) a MD:CD Tensile Ratio less than about 2.0 and a geometric mean tear strength greater than about 12.0 N.

5 In other embodiments the present invention provides a tissue product comprising at least one multi-layered tissue web having first and second outer layers and a middle layer disposed there-between, the web comprising from about 5 to about 30 weight percent non-wood cellulosic fibers having an average fiber length from about 1.0 to about 2.0 mm, the product having a MD:CD Tensile Ratio less than about 2.0, a geometric mean tensile (GMT) greater than about 700 g/3" and a MD Slope less than about 10.0 kg.

10 In still other embodiments the present disclosure provides a method of forming a tissue web comprising the steps of dispersing a wood pulp fiber and a non-wood cellulosic fiber in water to form a first fiber slurry, dispersing a wood pulp fiber to form a second fiber slurry, depositing the second fiber slurry onto a forming fabric, depositing the first fiber slurry adjacent to the second fiber slurry to form a wet web, dewatering the wet web to a consistency from about 20 to about 30 percent, and drying the
15 wet web to a consistency of greater than about 90 percent thereby forming a dry tissue web, the dry tissue web comprising from about 5 to about 30 weight percent non-wood cellulosic fibers.

In yet other embodiments the present disclosure provides a method of modifying at least one cross-machine direction property of a tissue web comprising the steps of dispersing hardwood kraft pulp and a non-wood cellulosic fiber selected from the group consisting of *Hesperaloe funifera*, *Hesperaloe*
20 *nocturna*, *Hesperaloe parviflora*, *Hesperaloe chiangii*, *Agave tequilana*, *Agave sisalana*, *Agave fourcroydes*, *Phyllostachys edulis*, *Bambusa vulgaris*, *Phyllostachys nigra* and combinations thereof, in water to form a first fiber slurry, dispersing softwood kraft pulp fiber to form a second fiber slurry, depositing the second fiber slurry onto a forming fabric, depositing the first fiber slurry adjacent to the second fiber slurry to form a wet web, dewatering the wet web to a consistency from about 20 to about
25 30 percent, and drying the wet web to a consistency of greater than about 90 percent thereby forming a dry tissue web, the dry tissue web comprising from about 5 to about 30 weight percent non-wood cellulosic fibers and having a CD tensile, CD slope, CD tear or CD tensile energy absorption different than a similarly manufactured tissue web substantially free from non-wood cellulosic fiber. In certain embodiments first fiber slurry is not subject to refining and the second fiber slurry is optionally refined.

30 **DESCRIPTIONS OF THE DRAWINGS**

Figure 1 is a graph of CD slope (y-axis) versus geometric mean tensile (GMT, x-axis) for three different tissue products manufactured at three different geometric mean tensile strengths, - ● - are

tissue products having three layers and comprising 40% NSWK and 60% EHWK, -▲- are tissue products having three layers and comprising 40% NSWK, 45% EHWK and 15% bamboo; and -■- are tissue products having three layers and comprising 40% NSWK, 30% EHWK and 30% bamboo;

Figure 2 is a graph of MD slope (y-axis) versus geometric mean tensile (GMT, x-axis) for three different tissue products manufactured at three different geometric mean tensile strengths, -●- are tissue products having three layers and comprising 40% NSWK and 60% EHWK, -▲- are tissue products having three layers and comprising 40% NSWK, 45% EHWK and 15% bamboo; and -■- are tissue products having three layers and comprising 40% NSWK, 30% EHWK and 30% bamboo; and

Figure 3 is a graph of GM tear (y-axis) versus geometric mean tensile (GMT, x-axis) for three different tissue products manufactured at three different geometric mean tensile strengths, -●- are tissue products having three layers and comprising 40% NSWK and 60% EHWK, -▲- are tissue products having three layers and comprising 40% NSWK, 45% EHWK and 15% bamboo; and -■- are tissue products having three layers and comprising 40% NSWK, 30% EHWK and 30% bamboo.

DEFINITIONS

As used herein, the term "Average Fiber Length" means the length weighted average fiber length (LWAFI) of fibers determined utilizing OpTest Fiber Quality Analyzer, model FQA-360 (OpTest Equipment, Inc., Hawkesbury, ON). According to the test procedure, a pulp sample is treated with a macerating liquid to ensure that no fiber bundles or shives are present. Each pulp sample is disintegrated into hot water and diluted to an approximately 0.001 percent solution. Individual test samples are drawn in approximately 50 to 100 ml portions from the dilute solution when tested using the standard OpTest Fiber Quality Analyzer fiber analysis test procedure. The weighted average fiber length may be expressed by the following equation:

$$\sum_{x_i=0}^k (x_i \times n_i) / n$$

where k = maximum fiber length

x_i = fiber length

n_i = number of fibers having length x_i

n = total number of fibers measured.

As used herein, the term "Coarseness" means the fiber mass per unit of unweighted fiber length reported in units of milligrams per one hundred meters of unweighted fiber length (mg/100 m) as

measured using a suitable fiber coarseness measuring device such as the above OpTest Fiber Quality Analyzer. The coarseness of the pulp is an average of three coarseness measurements of three fiber specimens taken from the pulp. The operation of the analyzer for measuring coarseness is similar to the operation for measuring fiber length described above.

- 5 As used herein the term "Fiber" means an elongate particulate having an apparent length greatly exceeding its apparent width. More specifically, and as used herein, fiber means such fibers suitable for a papermaking process and more particularly the tissue paper making process.

As used herein the term "Cellulosic Fiber" means a fiber composed of or derived from cellulose.

- As used herein, the term "Long Cellulosic Fibers" means a cellulosic fiber having an average
10 fiber length greater than 1.2 mm and more preferably greater than about 1.5 mm and still more preferably greater than about 1.8 mm, such as from about 1.2 to about 3.0 mm and more preferably from about 1.5 to about 2.5 mm.

- As used herein the term "Short Cellulosic Fibers" means a cellulosic fiber having an average
length less than about 1.2 mm, such as from about 0.4 to about 1.2 mm, such as from about 0.5 to about
15 0.75 mm, and more preferably from about 0.6 to about 0.7 mm. One example of short cellulosic fibers are hardwood pulp fibers, which may be derived from hardwoods selected from the group consisting of Acacia, Eucalyptus, Maple, Oak, Aspen, Birch, Cottonwood, Alder, Ash, Cherry, Elm, Hickory, Poplar, Gum, Walnut, Locust, Sycamore and Beech.

- As used herein the term "Non-Wood Cellulosic Fiber" means a fibers derived from non-wood
20 plants including, for example, non-wood plants in the genus *Hesperaloe* in the family Agavaceae including, such as *H. funifera*, *H. nocturna*, *H. parviflora*, and *H. changii*, non-wood plants in the genus *Agave*, of the family Asparagaceae including, for example *A. tequilana*, *A. sisalana* and *A. fourcroydes* and non-wood plants in the genus *Phyllostachys* or *Bambusa*, of the family Poaceae including, for example, *Phyllostachys edulis*, *Bambusa vulgaris* and *Phyllostachys nigra* variant Henon.

- 25 As used herein, the term "Tissue Product" means products made from tissue webs and includes, bath tissues, facial tissues, paper towels, industrial wipers, foodservice wipers, napkins, medical pads, and other similar products.

As used herein, the term "Tissue Web" means a fibrous sheet material suitable for use as a tissue product.

- 30 As used herein, the term "Ply" means a discrete product element. Individual plies may be arranged in juxtaposition to each other. The term may refer to a plurality of web-like components such as in a multi-ply facial tissue, bath tissue, paper towel, wipe, or napkin.

As used herein, the term "Layer" means a plurality of strata of fibers, chemical treatments, or the like, within a ply.

As used herein, the terms "Layered," "Multi-Layered," and the like, refer to fibrous sheets prepared from two or more layers of aqueous papermaking furnish which are preferably comprised of different fiber types. The layers are preferably formed from the deposition of separate streams of dilute fiber slurries, upon one or more endless foraminous screens. If the individual layers are initially formed on separate foraminous screens, the layers are subsequently combined (while wet) to form a layered composite web.

As used herein the term "Basis Weight" means the bone dry weight per unit area of a tissue and is generally expressed as grams per square meter (gsm). Basis weight is measured using TAPPI test method T-220. While basis weight may be varied, tissue products prepared according to the present invention and comprising one, two or three plies, generally have a basis weight greater than about 30 gsm, such as from about 30 to about 60 gsm and more preferably from about 35 to about 45 gsm.

As used herein the term "Caliper" is the representative thickness of a single sheet (caliper of tissue products comprising two or more plies is the thickness of a single sheet of tissue product comprising all plies) measured in accordance with TAPPI test method T402 using an EMVECO 200-A Microgauge automated micrometer (EMVECO, Inc., Newberg, OR). The micrometer has an anvil diameter of 2.22 inches (56.4 mm) and an anvil pressure of 132 grams per square inch (per 6.45 square centimeters) (2.0 kPa). The caliper of a tissue product may vary depending on a variety of manufacturing processes and the number of plies in the product, however, tissue products prepared according to the present invention generally have a caliper greater than about 500 μm , more preferably greater than about 575 μm and still more preferably greater than about 600 μm , such as from about 500 to about 800 μm and more preferably from about 600 to about 750 μm .

As used herein the term "Sheet Bulk" refers to the quotient of the caliper (generally having units of μm) divided by the bone dry basis weight (generally having units of gsm). The resulting sheet bulk is expressed in cubic centimeters per gram (cc/g). Through-air dried tissue products prepared according to the present invention generally have a sheet bulk greater than about 8 cc/g, more preferably greater than about 10 cc/g and still more preferably greater than about 12 cc/g, such as from about 8 to about 20 cc/g and more preferably from about 12 to about 18 cc/g. Creped wet pressed tissue products prepared according to the present invention generally have a sheet bulk greater than about 7 cc/g, more preferably greater than about 9 cc/g, such as from about 7 to about 10 cc/g.

As used herein, the term "Geometric Mean Tensile" (GMT) refers to the square root of the product of the machine direction tensile strength and the cross-machine direction tensile strength of the

tissue product. While the GMT may vary, tissue products prepared according to the present invention generally have a GMT greater than about 500 g/3", more preferably greater than about 600 g/3" and still more preferably greater than about 800 g/3", such as from about 500 to about 1,200 g/3".

As used herein, the term "Slope" refers to the slope of the line resulting from plotting tensile
5 versus stretch and is an output of the MTS TestWorks™ in the course of determining the tensile strength as described in the Test Methods section herein. Slope is reported in the units of grams (g) per unit of sample width (inches) and is measured as the gradient of the least-squares line fitted to the load-corrected strain points falling between a specimen-generated force of 70 to 157 grams (0.687 to 1.540 N) divided by the specimen width. Slopes are generally reported herein as having units of grams (g) or
10 kilograms (kg).

As used herein, the term "Geometric Mean Slope" (GM Slope) refers to the square root of the product of machine direction slope and cross-machine direction slope. GM Slope generally is expressed in units of kilograms (kg). While the GM Slope may vary, tissue products prepared according to the present invention generally have a GM Slope less than about 10.0 kg, more preferably less than about
15 8.0 kg and still more preferably less than about 6.0 kg.

As used herein, the term "Stiffness Index" refers to GM Slope (having units of kg), divided by GMT (having units of g/3") multiplied by 1,000. While the Stiffness Index may vary, tissue products prepared according to the present invention generally have a Stiffness Index less than about 10.0 and more preferably less than about 8.0, such as from about 6.0 to about 10.0.

20 As used herein, the term "Geometric Mean Tensile Energy Absorption" (GM TEA) refers to the square root of the product MD TEA and CD TEA, which are measured in the course of determining tensile strength as described below. GM TEA has units of gm*cm/cm².

As used herein the term "Substantially Free" when used in reference to a given layer of a multi-layered fibrous web means the given layer comprises less than about 0.25 percent of the subject fiber,
25 by weight of the layer. The foregoing amounts of fiber are generally considered negligible and do not affect the physical properties of the layer. Moreover the presence of negligible amounts of subject fibers in a given layer generally arise from fibers disposed in an adjacent layer, and have not been purposefully disposed in a given layer. For example where a given layer of a multi-layered tissue web is said to be substantially free of wood pulp fibers, the given layer generally comprises less than about 0.25 percent
30 wood pulp fiber, by weight of the layer.

DETAILED DESCRIPTION OF THE DISCLOSURE

The present invention provides multi-layered tissue webs, and tissue product comprising the same, the multi-layered webs comprising wood fibers and non-wood cellulosic fibers where the non-wood cellulosic fibers are selectively deposited in one or more outer layers of the multi-layered web.

5 Surprisingly disposing non-wood cellulosic fibers in the outer layers, even in relatively modest amounts, alters the machine and/or cross-machine direction properties of the resulting web, such that MD:CD tensile ratio may be reduced. For example, in one embodiment, the present invention provides a method of manufacturing a tissue web comprising the steps of dispersing hardwood kraft pulp and a non-wood cellulosic fiber in water to form a first fiber slurry, dispersing softwood kraft pulp fiber to form a second

10 fiber slurry, depositing the second fiber slurry onto a forming fabric, depositing the first fiber slurry adjacent to the second fiber slurry to form a wet web, dewatering the wet web to a consistency from about 20 to about 30 percent, and drying the wet web to a consistency of greater than about 90 percent thereby forming a dry tissue web, the dry tissue web comprising from about 5 to about 30 weight percent non-wood cellulosic fibers and having a MD:CD tensile ratio less than about 2.0. In particularly preferred

15 embodiments the first fiber slurry is not refined, that is neither the hardwood kraft pulp nor the non-wood cellulosic fibers are refined. The second fiber slurry may optionally be refined to modify the strength of the resulting tissue web.

Tissue webs and products of the present invention generally comprise at least about 5.0 weight percent non-wood cellulosic fibers and more preferably at least about 10 weight percent, such as from

20 about 5.0 to about 30 percent and more preferably from about 10 to about 25 weight percent. In particularly preferred embodiments the inventive tissue products comprise a multi-layered web comprising a first layer, such as a fabric contacting layer, and a second layer, such as an air layer, where the first layer comprises non-wood cellulosic fiber and wood pulp fibers, preferably short wood fibers, and the second layer comprises wood pulp fibers and is substantially free from non-wood cellulosic

25 fibers.

Non-wood cellulosic fibers useful in the present invention are generally derived from non-wood plants in the genus *Hesperaloe* in the family *Agavaceae* including, for example *H. funifera*, *H. nocturna*, *H. parviflora*, and *H. changii*, non-wood plants in the genus *Agave*, of the family *Asparagaceae* including, for example *A. tequilana*, *A. sisalana* and *A. fourcroydes* and non-wood plants in the genus

30 *Phyllostachys* or *Bambusa*, of the family *Poaceae* including, for example, *Phyllostachys edulis*, *Bambusa vulgaris* and *Phyllostachys nigra* variant Henon. Preferably the non-wood cellulosic fiber has an average fiber length greater than about 1.0 mm, more preferably greater than about 1.2 mm and still more preferably greater than about 1.4 mm, such as an average fiber length from about 1.0 to about 3.0 mm

and more preferably from about 1.2 to about 2.8 mm. In certain embodiments the tissue webs and products may comprise two or more different non-wood cellulosic fibers.

In particularly preferred embodiments the non-wood cellulosic fiber is a bamboo fiber derived from one or more bamboo fiber species selected from the group consisting of *Acidosasa* sp.,
 5 *Ampleocalamus* sp., *Arundinaria* sp., *Bambusa* sp., *Bashania* sp., *Borinda* sp., *Brachystachyum* sp.,
Cephalostachyum sp., *Chimonobambusa* sp., *Chusquea* sp., *Dendrocalamus* sp., *Dinorchloa* sp.,
Drepanostachyum sp., *Eremitis* sp., *Fargesia* sp., *Gaoligongshania* sp., *Gelidocalamus* sp.,
Gigantochloa sp., *Guadua* sp., *Hibanobambusa* sp., *Himalayacalamus* sp., *Indocalamus* sp., *Indosasa*
 sp., *Lithachne* sp., *Melocanna* sp., *Menstruocalamus* sp., *Nastus* sp., *Neohouzeaua* sp.,
 10 *Neomicrocalamus* sp., *Ochlandra* sp., *Oligostachyum* sp., *Olmea* sp., *Otatea* sp., *Oxytenanthera* sp.,
Phyllostachys sp., *Pleioblastus* sp., *Pseudosasa* sp., *Raddia* sp., *Rhipidocladum* sp., *Sasa* sp., *Sasaella*
 sp., *Sasamorphia* sp., *Schizostachyum* sp., *Semiarundinaria* sp., *Shibatea* sp., *Sinobambusa* sp.,
Thamnocalamus sp., *Thyrsostachys* sp., and *Yushania* sp.

Tissue webs and products made in accordance with the present disclosure are formed from a
 15 stratified fiber furnish producing layers within the web or product. Stratified base webs can be formed
 using equipment known in the art, such as a multi-layered headbox. For example, in certain
 embodiments, the tissue products may be prepared from multi-layered webs having a first outer layer, a
 middle layer and a second outer layer. In one embodiment the first and second outer layers may
 comprise non-wood cellulosic fiber and short cellulosic fiber, such as hardwood pulp fibers. The short
 20 cellulosic fibers can be mixed, if desired, with paper broke in an amount up to about 10 percent by weight
 and/or long cellulosic fiber in an amount up to about 10 percent by weight. The middle layer, which is
 generally positioned in between the first outer layer and the second outer layer may comprise wood
 fibers, and more preferably long, low coarseness wood pulp fibers, such as Northern softwood kraft pulp
 fibers (NSWK). Preferably the middle layer is substantially free from non-wood cellulosic fibers.

In other embodiments the non-wood cellulosic fibers are utilized in the tissue web as a
 25 replacement for short wood fibers such as hardwood kraft pulp fibers and more specifically Eucalyptus
 kraft fibers. In one particular embodiment, non-wood cellulosic fibers are incorporated into a multi-
 layered web having an air contacting layer (non-fabric contacting layer) and a fabric contacting layer
 where the air contacting layer comprises a blend of hardwood fibers and non-wood cellulosic fibers and
 30 the fabric contacting layer comprises long wood fibers. In the foregoing embodiment the non-wood
 cellulosic fiber may be added to the air contacting layer such that the total web comprises about 5.0 to
 about 30 percent, by total weight of the web, non-wood cellulosic fibers. Further, it may be preferred to

selectively dispose the non-wood cellulosic fibers in the air layer such that the fabric contacting layer is substantially free from non-wood cellulosic fibers.

In a particularly preferred embodiment, the present disclosure provides a tissue web having modified machine and/or cross-machine direction physical properties and a MD:CD tensile ratio less than about 2.0. For example, the invention provides a tissue product having a GMT greater than about 500 g/3", such as from about 500 to about 1,200 g/3", and more preferably from about 700 to about 1,000 g/3", a MD:CD tensile ratio less than about 2.0, such as from about 1.5 to about 2.0 and more preferably from about 1.6 to about 1.80 and a reduced MD Slope, such as a MD Slope less than about 10.0 kg, and more preferably less than about 8.0 kg, such as from about 6.0 to about 10.0 kg and more preferably from about 6.0 to about 8.0 kg.

In other embodiments, the addition of non-wood fibers to one or more outer layers of a multi-layered tissue web may alter the CD Slope and in some instances may increase the CD Slope, compared to a similarly manufactured tissue web that is substantially free from non-wood fibers. For example, a tissue multi-layered web comprising from about 10 to about 50 percent non-wood fiber, where the non-wood fiber is selectively incorporated in one or more outer layers may have a CD Slope from about 4.5 to about 6.0 kg.

In still other embodiments, the present disclosure provides tissue products having enhanced durability, such as improved tear strength. For example, tissue products prepared as described herein may have a geometric mean tear (GM tear) greater than about 12.0 N and more preferably greater than about 14.0 N and still more preferably greater than about 16.0 N, such as from about 12.0 to about 20.0 at geometric mean tensile strengths from about 700 to about 1,200 g/3".

The increase in durability is generally achieved without a corresponding increase in stiffness, such that the instant tissue products are durable, yet flexible and soft. For example, tissue products prepared as described herein may have a GM Slope less than about 8.0 and more preferably less than about 7.0, such as from about 5.0 to about 8.0. The foregoing GM Slopes are generally achieved at GMTs from about 700 to about 1,200 g/3" and more preferably from about 750 to about 1,000 g/3" yielding Stiffness Indexes less than about 9.0, and more preferably less than about 8.0 and still more preferably less than about 7.0, such as from about 6.0 to about 9.0.

Webs prepared as described herein may be converted into either single or multi-ply rolled tissue products that have improved properties over the prior art. In one embodiment the present disclosure provides a rolled tissue product comprising a spirally wound tissue web having at least two layers wherein the air contacting layer comprises at least about 5 percent, by weight of the web, non-wood

cellulosic fiber and wherein the tissue web has a bone dry basis weight greater than about 35 gsm, a sheet bulk greater than about 10 cc/g and a Stiffness Index less than about 9.0.

The tissue webs may also be incorporated into tissue products that may be either single- or multi-ply, where one or more of the plies may be formed by a multi-layered tissue web having non-wood cellulosic fiber selectively incorporated in one of its layers. In one embodiment the tissue product is constructed such that the non-wood cellulosic fibers are brought into contact with the user's skin in-use. For example, the tissue product may comprise two multi-layered through-air dried webs wherein each web comprises a fabric contacting fibrous layer substantially free from non-wood cellulosic fiber and a non-fabric contacting fibrous layer comprising non-wood cellulosic fiber. The webs are plied together such that the outer surface of the tissue product is formed from the fabric contacting fibrous layers of each web, such that the surface brought into contact with the user's skin in-use comprises non-wood cellulosic fiber.

If desired, various chemical compositions may be applied to one or more layers of the multi-layered tissue web to further enhance softness and/or reduce the generation of lint or slough. For example, in some embodiments, a wet strength agent can be utilized to further increase the strength of the tissue product when wet. As used herein, a "wet strength agent" is any material that when added to pulp fibers can provide a resulting web or sheet with a wet geometric tensile strength to dry geometric tensile strength ratio in excess of about 0.1. Typically these materials are termed either "permanent" wet strength agents or "temporary" wet strength agents. As is well known in the art, temporary and permanent wet strength agents may also sometimes function as dry strength agents to enhance the strength of the tissue product when dry.

Wet strength agents may be applied in various amounts depending on the desired characteristics of the web. For instance, in some embodiments, the total amount of wet strength agents added can be between about 1 to about 60 pounds per ton (lbs/T), in some embodiments between about 5 to about 30 lbs/T, and in some embodiments between about 7 to about 13 lbs/T of the dry weight of fibrous material. The wet strength agents can be incorporated into any layer of the multi-layered tissue web.

A chemical debonder can also be applied to soften the web. Specifically, a chemical debonder can reduce the amount of hydrogen bonds within one or more layers of the web, which results in a softer product. Depending on the desired characteristics of the resulting tissue product, the debonder can be utilized in varying amounts. For example, in some embodiments, the debonder can be applied in an amount between about 1 to about 30 lbs/T, in some embodiments between about 3 to about 20 lbs/T,

and in some embodiments, between about 6 to about 15 lbs/T of the dry weight of fibrous material. The debonder can be incorporated into any layer of the multi-layered tissue web.

Any material capable of enhancing the soft feel of a web by disrupting hydrogen bonding can generally be used as a debonder in the present invention. In particular, as stated above, it is typically
5 desired that the debonder possess a cationic charge for forming an electrostatic bond with anionic groups present on the pulp. Some examples of suitable cationic debonders can include, but are not limited to, quaternary ammonium compounds, imidazolinium compounds, bis-imidazolinium compounds, diquaternary ammonium compounds, polyquaternary ammonium compounds, ester-functional quaternary ammonium compounds (e.g., quaternized fatty acid trialkanolamine ester salts), phospholipid
10 derivatives, polydimethylsiloxanes and related cationic and non-ionic silicone compounds, fatty and carboxylic acid derivatives, mono and polysaccharide derivatives, polyhydroxy hydrocarbons, etc. For instance, some suitable debonders are described in U.S. Pat. Nos. 5,716,498, 5,730,839, 6,211,139, 5,543,067, and WO/0021918, all of which are incorporated herein in a manner consistent with the present disclosure.

15 Still other suitable debonders are disclosed in U.S. Pat. Nos. 5,529,665 and 5,558,873, both of which are incorporated herein in a manner consistent with the present disclosure. In particular, U.S. Pat. No. 5,529,665 discloses the use of various cationic silicone compositions as softening agents.

Tissue webs of the present disclosure can generally be formed by any of a variety of papermaking processes known in the art. Preferably the tissue web is formed by through-air drying and
20 be either creped or uncreped. For example, a papermaking process of the present disclosure can utilize adhesive creping, wet creping, double creping, embossing, wet-pressing, air pressing, through-air drying, creped through-air drying, uncreped through-air drying, as well as other steps in forming the paper web. Some examples of such techniques are disclosed in U.S. Pat. Nos. 5,048,589, 5,399,412, 5,129,988 and 5,494,554 all of which are incorporated herein in a manner consistent with the present
25 disclosure. When forming multi-ply tissue products, the separate plies can be made from the same process or from different processes as desired.

For example, in one embodiment, tissue webs may be creped through-air dried webs formed using processes known in the art. To form such webs, an endless traveling forming fabric, suitably supported and driven by rolls, receives the layered papermaking stock issuing from the headbox. A
30 vacuum box is disposed beneath the forming fabric and is adapted to remove water from the fiber furnish to assist in forming a web. From the forming fabric, a formed web is transferred to a second fabric, which may be either a wire or a felt. The fabric is supported for movement around a continuous path by a

plurality of guide rolls. A pick up roll designed to facilitate transfer of web from fabric to fabric may be included to transfer the web.

Preferably the formed web is dried by transfer to the surface of a rotatable heated dryer drum, such as a Yankee dryer. The web may be transferred to the Yankee directly from the throughdrying
5 fabric or, preferably, transferred to an impression fabric which is then used to transfer the web to the Yankee dryer. In accordance with the present disclosure, the creping composition of the present disclosure may be applied topically to the tissue web while the web is traveling on the fabric or may be applied to the surface of the dryer drum for transfer onto one side of the tissue web. In this manner, the creping composition is used to adhere the tissue web to the dryer drum. In this embodiment, as the web
10 is carried through a portion of the rotational path of the dryer surface, heat is imparted to the web causing most of the moisture contained within the web to be evaporated. The web is then removed from the dryer drum by a creping blade. The creping web as it is formed further reduces internal bonding within the web and increases softness. Applying the creping composition to the web during creping, on the other hand, may increase the strength of the web.

15 In other embodiments, the base web is formed by an uncreped through-air drying process such as those described, for example, in U.S. Pat. Nos. 5,656,132 and 6,017,417, both of which are hereby incorporated by reference herein in a manner consistent with the present disclosure. The uncreped through-air drying process may comprise a twin wire former having a papermaking headbox which injects or deposits a furnish of an aqueous suspension of wood fibers onto a plurality of forming fabrics, such
20 as an outer forming fabric and an inner forming fabric, thereby forming a wet tissue web. The forming process may be any conventional forming process known in the papermaking industry. Such formation processes include, but are not limited to, Fourdriniers, roof formers such as suction breast roll formers, and gap formers such as twin wire formers and crescent formers.

The wet tissue web forms on the inner forming fabric as the inner forming fabric revolves about
25 a forming roll. The inner forming fabric serves to support and carry the newly-formed wet tissue web downstream in the process as the wet tissue web is partially dewatered to a consistency of about 10 percent based on the dry weight of the fibers. Additional dewatering of the wet tissue web may be carried out by known paper making techniques, such as vacuum suction boxes, while the inner forming fabric supports the wet tissue web. The wet tissue web may be additionally dewatered to a consistency of at
30 least about 20 percent, more specifically between about 20 to about 40 percent, and more specifically about 20 to about 30 percent.

The forming fabric can generally be made from any suitable porous material, such as metal wires or polymeric filaments. For instance, some suitable fabrics can include, but are not limited to,

Albany 84M and 94M available from Albany International (Albany, N.Y.) Asten 856, 866, 867, 892, 934, 939, 959, or 937; Asten Synweve Design 274, all of which are available from Asten Forming Fabrics, Inc. (Appleton, Wis.); and Voith 2164 available from Voith Fabrics (Appleton, Wis.). The wet web is then transferred from the forming fabric to a transfer fabric while at a solids consistency of between about 10 to about 35 percent and, particularly, between about 20 to about 30 percent. As used herein, a "transfer fabric" is a fabric that is positioned between the forming section and the drying section of the web manufacturing process.

Transfer to the transfer fabric may be carried out with the assistance of positive and/or negative pressure. For example, in one embodiment, a vacuum shoe can apply negative pressure such that the forming fabric and the transfer fabric simultaneously converge and diverge at the leading edge of the vacuum slot. Typically, the vacuum shoe supplies pressure at levels between about 10 to about 25 inches of mercury. As stated above, the vacuum transfer shoe (negative pressure) can be supplemented or replaced by the use of positive pressure from the opposite side of the web to blow the web onto the next fabric. In some embodiments, other vacuum shoes can also be used to assist in drawing the fibrous web onto the surface of the transfer fabric. The wet tissue web is then transferred from the transfer fabric to a throughdrying fabric.

While supported by the throughdrying fabric, the wet tissue web is dried to a final consistency of about 94 percent or greater by a throughdryer. The drying process can be any noncompressive drying method which tends to preserve the bulk or thickness of the wet web including, without limitation, throughdrying, infra-red radiation, microwave drying, etc. Because of its commercial availability and practicality, throughdrying is well known and is one commonly used means for noncompressively drying the web for purposes of this invention. Suitable throughdrying fabrics include, without limitation, fabrics with substantially continuous machine direction ridges whereby the ridges are made up of multiple warp strands grouped together, such as those disclosed in U.S. Pat. No. 6,998,024. Other suitable throughdrying fabrics include those disclosed in U.S. Pat. No. 7,611,607, which is incorporated herein in a manner consistent with the present disclosure, particularly the fabrics denoted as Fred (t1207-77), Jetson (t1207-6) and Jack (t1207-12). The web is preferably dried to final dryness on the throughdrying fabric, without being pressed against the surface of a Yankee dryer, and without subsequent creping.

Additionally, webs prepared according to the present disclosure may be subjected to any suitable post processing including, but not limited to, printing, embossing, calendering, slitting, folding, winding, combining with other tissue webs, and the like. Post processing of the web generally results in a tissue product that is intended for use by a consumer.

TEST METHODS

Sheet Bulk

Sheet Bulk is calculated as the quotient of the dry sheet caliper (μm) divided by the basis weight (gsm). Dry sheet caliper is the measurement of the thickness of a single tissue sheet measured in accordance with TAPPI test methods T402 and T411 om-89. The micrometer used for carrying out T411 om-89 is an Emvecc 200-A Tissue Caliper Tester (Emveco, Inc., Newberg, OR). The micrometer has a load of 2 kilo-Pascals, a pressure foot area of 2500 square millimeters, a pressure foot diameter of 56.42 millimeters, a dwell time of 3 seconds and a lowering rate of 0.8 millimeters per second.

Tear

Tear testing was carried out in accordance with TAPPI test method T-414 "Internal Tearing Resistance of Paper (Elmendorf-type method)" using a falling pendulum instrument such as Lorentzen & Wettre Model SE 009. Tear strength is directional and MD and CD tear are measured independently.

More particularly, a rectangular test specimen of the sample to be tested is cut out of the tissue product or tissue basesheet such that the test specimen measures 63 ± 0.15 mm (2.5 ± 0.006 inches) in the direction to be tested (such as the MD or CD direction) and between 73 and 114 millimeters (2.9 and 4.6 inches) in the other direction. The specimen edges must be cut parallel and perpendicular to the testing direction (not skewed). Any suitable cutting device, capable of the prescribed precision and accuracy, can be used. The test specimen should be taken from areas of the sample that are free of folds, wrinkles, crimp lines, perforations or any other distortions that would make the test specimen abnormal from the rest of the material.

The number of plies or sheets to test is determined based on the number of plies or sheets required for the test results to fall between 20 to 80 percent on the linear range scale of the tear tester and more preferably between 20 to 60 percent of the linear range scale of the tear tester. The sample preferably should be cut no closer than 6 mm (0.25 inch) from the edge of the material from which the specimens will be cut. When testing requires more than one sheet or ply the sheets are placed facing in the same direction.

The test specimen is then placed between the clamps of the falling pendulum apparatus with the edge of the specimen aligned with the front edge of the clamp. The clamps are closed and a 20-millimeter slit is cut into the leading edge of the specimen usually by a cutting knife attached to the instrument. For example, on the Lorentzen & Wettre Model SE 009 the slit is created by pushing down on the cutting knife lever until it reaches its stop. The slit should be clean with no tears or nicks as this slit will serve to start the tear during the subsequent test.

The pendulum is released and the tear value, which is the force required to completely tear the test specimen, is recorded. The test is repeated a total of ten times for each sample and the average of the ten readings reported as the tear strength. Tear strength is reported in units of grams of force (gf). The average tear value is the tear strength for the direction (MD or CD) tested. The "geometric mean
5 tear strength" is the square root of the product of the average MD tear strength and the average CD tear strength. The Lorentzen & Wettre Model SE 009 has a setting for the number of plies tested. Some testers may need to have the reported tear strength multiplied by a factor to give a per ply tear strength. For basesheets intended to be multiple ply products, the tear results are reported as the tear of the multiple ply product and not the single ply basesheet. This is done by multiplying the single ply basesheet
10 tear value by the number of plies in the finished product. Similarly, multiple ply finished product data for tear is presented as the tear strength for the finished product sheet and not the individual plies. A variety of means can be used to calculate but in general will be done by inputting the number of sheets to be tested rather than number of plies to be tested into the measuring device. For example, two sheets would be two 1-ply sheets for 1-ply product and two 2-ply sheets (4-ply) for 2-ply products.

15 Tensile

Tensile testing was done in accordance with TAPPI test method T-576 "Tensile properties of towel and tissue products (using constant rate of elongation)" wherein the testing is conducted on a tensile testing machine maintaining a constant rate of elongation and the width of each specimen tested is 3 inches. More specifically, samples for dry tensile strength testing were prepared by cutting a 3 ±
20 0.05 inches (76.2 ± 1.3 mm) wide strip in either the machine direction (MD) or cross-machine direction (CD) orientation using a JDC Precision Sample Cutter (Thwing-Albert Instrument Company, Philadelphia, PA, Model No. JDC 3-10, Serial No. 37333) or equivalent. The instrument used for measuring tensile strengths was an MTS Systems Sintech 11S, Serial No. 6233. The data acquisition software was an MTS TestWorks® for Windows Ver. 3.10 (MTS Systems Corp., Research Triangle Park, NC). The load cell was selected from either a 50 Newton or 100 Newton maximum, depending on the
25 strength of the sample being tested, such that the majority of peak load values fall between 10 to 90 percent of the load cell's full scale value. The gauge length between jaws was 4 ± 0.04 inches (101.6 ± 1 mm) for facial tissue and towels and 2 ± 0.02 inches (50.8 ± 0.5 mm) for bath tissue. The crosshead speed was 10 ± 0.4 inches/min (254 ± 1 mm/min), and the break sensitivity was set at 65 percent. The
30 sample was placed in the jaws of the instrument, centered both vertically and horizontally. The test was then started and ended when the specimen broke. The peak load was recorded as either the "MD tensile strength" or the "CD tensile strength" of the specimen depending on direction of the sample being tested. Ten representative specimens were tested for each product or sheet and the arithmetic average of all

individual specimen tests was recorded as the appropriate MD or CD tensile strength the product or sheet in units of grams of force per 3 inches of sample. The geometric mean tensile (GMT) strength was calculated and is expressed as grams-force per 3 inches of sample width. Tensile energy absorbed (TEA) and slope are also calculated by the tensile tester. TEA is reported in units of gm*cm/cm². Slope is recorded in units of kg. Both TEA and Slope are directional dependent and thus MD and CD directions are measured independently. Geometric mean TEA and geometric mean slope are defined as the square root of the product of the representative MD and CD values for the given property.

Multi-ply products were tested as multi-ply products and results represent the tensile strength of the total product. For example, a 2-ply product was tested as a 2-ply product and recorded as such. A basesheet intended to be used for a 2-ply product was tested as two plies and the tensile recorded as such. Alternatively, a single ply may be tested and the result multiplied by the number of plies in the final product to get the tensile strength.

EXAMPLES

Base sheets were made using a through-air dried papermaking process commonly referred to as "uncreped through-air dried" ("UCTAD") and generally described in U.S. Pat. No. 5,607,551, the contents of which are incorporated herein in a manner consistent with the present invention. Initially, northern softwood kraft (NSWK) pulp was dispersed in a pulper for 30 minutes at 4 percent consistency at about 100°F. The NSWK pulp was then transferred to a dump chest and subsequently diluted to approximately 3 percent consistency. The NSWK pulp was refined at about 1 HP-days/MT as set forth in Table 2, below. The softwood fibers were added to the middle side layer in the 3-layer tissue structure. The virgin NSWK fiber content contributed approximately 40 percent of the final sheet weight.

Eucalyptus hardwood kraft (EHWK) pulp was dispersed in a pulper for 30 minutes at about 4 percent consistency at about 100°F. The EHWK pulp was then transferred to a dump chest and subsequently diluted to about 3 percent consistency. The EHWK was not refined.

The non-wood cellulosic fibers were bamboo kraft pulp, which had the following properties:

TABLE 1

Non-wood cellulosic fiber	Average Fiber Length (mm)	Coarseness (mg/100 m)
Bamboo Kraft Pulp	1.30	9.17

Bamboo pulp fibers were dispersed in a pulper for 30 minutes at 4 percent consistency at about 100°F. The bamboo pulp was then transferred to a dump chest and subsequently diluted to approximately 3 percent consistency. The bamboo pulp was not refined.

In certain instances starch (Redibond 2038A, Ingredion Incorporated, Englewood, CO) was added to each furnish layer prior to formation of the web. Starch was added to the machine chest where it was mixed prior to the headbox. Starch addition levels are set forth in Table 2.

The pulp fibers from the machine chests were pumped to the headbox at a consistency of about 0.1 percent. Pulp fibers from each machine chest were sent through separate manifolds in the headbox to create a 3-layered tissue structure. The specific furnish layer splits are set forth in Table 2.

TABLE 2

Sample	Middle Layer (Wt. %)	Outer Layers (Wt. %)		Redibond 2038A Starch (kg/MT)	Refining (min.)
Control 1	NSWK (40%)	EHWK (60%)	-	-	3
Control 2	NSWK (40%)	EHWK (60%)	-	1	3
Control 3	NSWK (40%)	EHWK (60%)	-	2	3
Inventive 1	NSWK (40%)	EHWK (45%)	Bamboo (15%)	-	0
Inventive 2	NSWK (40%)	EHWK (45%)	Bamboo (15%)	2	0
Inventive 3	NSWK (40%)	EHWK (45%)	Bamboo (15%)	4	0
Inventive 4	NSWK (40%)	EHWK (30%)	Bamboo (30%)	-	0
Inventive 5	NSWK (40%)	EHWK (30%)	Bamboo (30%)	2	0
Inventive 6	NSWK (40%)	EHWK (30%)	Bamboo (30%)	4	0

The tissue web was formed on a Voith Fabrics TissueForm V forming fabric, vacuum dewatered to approximately 25 percent consistency and then subjected to rush transfer when transferred to the transfer fabric. The layer splits, by weight of the web, are detailed in Table 2, above. The transfer fabric was the fabric described as t1207-11 (commercially available from Voith Fabrics, Appleton, WI). The web was then transferred to a through-air drying fabric. Transfer to the through-drying fabric was done using vacuum levels of greater than 10 inches of mercury at the transfer. The web was then dried to approximately 98 percent solids before winding.

The base sheet webs were converted into rolled bath products by calendering using a conventional polyurethane/steel calender comprising a 4 P&J polyurethane roll on the air side of the sheet and a standard steel roll on the fabric side. The finished product comprised a single ply of base sheet. The finished products were subjected to physical testing, the results of which are summarized in Tables 3 and 4, below.

TABLE 3

Code	Basis Weight (gsm)	Caliper (microns)	Sheet Bulk (cc/g)	MD:CD Tensile Ratio	MD:CD Slope Ratio	GMT	GM Slope	Stiffness Index
Control 1	36.5	476	13.1	2.07	2.22	989	6.80	6.88
Control 2	36.3	499	13.8	1.98	2.19	1108	7.27	6.57
Control 3	37.1	534	14.4	1.98	2.11	1245	7.61	6.11
Inventive 1	36.7	506	13.8	1.83	1.57	741	6.19	8.36
Inventive 2	37.1	492	13.3	1.78	1.82	968	6.82	7.04
Inventive 3	36.7	525	14.3	1.78	1.86	1128	7.15	6.34
Inventive 4	36.3	455	12.5	1.72	1.28	742	6.17	8.31
Inventive 5	36.3	498	13.7	1.80	1.69	975	6.88	7.05
Inventive 6	36.2	489	13.5	1.65	1.66	1094	7.37	6.74

TABLE 4

Code	CD Tensile (g/3")	CD Slope (kg)	MD Tensile (g/3")	MD Slope (kg)	GM TEA (g*cm/cm ²)	GM Tear (N)
Control 1	690	4.60	1421	10.10	10.67	14.22
Control 2	790	4.93	1556	10.74	12.11	16.28
Control 3	885	5.25	1753	11.03	13.97	17.71
Inventive 1	549	4.95	1002	7.76	7.74	12.17
Inventive 2	727	5.10	1292	9.16	10.72	15.30
Inventive 3	846	5.26	1503	9.76	13.25	17.17
Inventive 4	567	5.49	972	6.95	7.84	11.76
Inventive 5	729	5.30	1305	8.93	11.06	15.95
Inventive 6	853	5.75	1404	9.46	12.92	18.31

The foregoing represents several examples of inventive tissue products prepared according to the present disclosure. In other embodiments, such as a first embodiment, the present invention provides a tissue product comprising at least one multi-layered tissue web comprising a first air contacting layer and a second fabric contacting layer, wherein the first air contacting layer comprises from about 5 to about 30 weight percent, by weight of the web, non-wood cellulosic fibers and the tissue product has a geometric mean tensile from about 500 to about 1,200 g/3" and a MD:CD Tensile ratio less than about 2.0.

In a second embodiment the present invention provides the tissue product of the first embodiment wherein the fabric contacting layer is substantially free from non-wood cellulosic fiber.

In a third embodiment the present invention provides the tissue product of the first or second embodiments wherein the non-wood cellulosic fiber is derived from a non-wood plant selected from the group consisting of *Hesperaloe funifera*, *Hesperaloe nocturna*, *Hesperaloe parviflora*, *Hesperaloe chiangii*, *Agave tequilana*, *Agave sisalana*, *Agave fourcroydes*, *Phyllostachys edulis*, *Bambusa vulgaris*, *Phyllostachys nigra* and combinations thereof.

In a fourth embodiment the present invention provides the tissue product of any one of the first through third embodiments wherein the non-wood cellulosic fiber has an average fiber length from about 1.0 to about 3.0 mm.

5 In a sixth embodiment the present invention provides the tissue product of any one of the first through fifth embodiments having a GMT from about 700 to about 1,000 g/3" and a MD Slope from about 6.0 to about 10.0 kg.

In a seventh embodiment the present invention provides the tissue product of any one of the first through sixth embodiments having a GMT from about 700 to about 1,000 g/3" and a Stiffness Index from about 6.0 to about 9.0.

10 In an eighth embodiment the present invention provides the tissue product of any one of the first through seventh embodiments wherein the product has a MD:CD slope ratio less than 2.0, such as from about 1.5 to about 2.0 and more preferably from about 1.5 to about 1.75.

In a ninth embodiment the present invention provides the tissue product of any one of the first through eighth embodiments wherein the tissue product has a GM Tear from about 12 to about 20 N.

15 In a tenth embodiment the present invention provides the tissue product of any one of the first through ninth embodiments wherein the tissue product has a GM TEA greater than about 7.0 g*cm/cm², such as from about 7.0 to about 14.0 g*cm/cm² and more preferably from about 9.0 to about 12.0 g*cm/cm².

20 In an eleventh embodiment the present invention provides the tissue product of the first through tenth embodiments wherein the product has a MD:CD tensile ratio from about 1.50 to about 1.80.

In a twelfth embodiment the present invention provides the tissue product of the first through eleventh embodiments wherein the product has a GM Slope from about 6.0 to about 10.0 kg.

25 In a thirteenth embodiment the present invention provides the tissue product of the first through twelfth embodiments wherein the non-wood cellulosic fiber is derived from a non-wood plant selected from *Phyllostachys edulis*, *Bambusa vulgaris*, *Phyllostachys nigra* and combinations thereof and has an average fiber length from about 1.2 to about 1.6 mm.

30 In a fourteenth embodiment the present invention provides a tissue product comprising at least one multi-layered tissue web comprising a first and a second outer layer and a middle layer disposed therebetween, wherein the outer layers comprise from about 5 to about 30 percent, by weight of the web, non-cellulosic fiber and the tissue product has a geometric mean tensile from about 500 to about 1,200 g/3" and a MD:CD Tensile ratio less than about 2.0.

In a fifteenth embodiment the present invention provides the tissue product of the fourteenth embodiment wherein the middle layer is substantially free from non-wood cellulosic fiber.

In a sixteenth embodiment the present invention provides the tissue product of the fourteenth or fifteenth embodiments wherein the non-wood cellulosic fiber has an average fiber length from about 1.0
5 to about 3.0 mm.

In a seventeenth embodiment the present invention provides the tissue product of any one of the fourteenth through sixteenth embodiments wherein the tissue product has a MD:CD slope ratio less than 2.0, such as from about 1.5 to about 2.0 and more preferably from about 1.5 to about 1.75.

In an eighteenth embodiment the present invention provides the tissue product of any one of
10 the fourteenth through seventeenth embodiments wherein the tissue product has a GM Tear greater than about 12 N, such as from about 12 to about 20 N.

In a nineteenth embodiment the present invention provides a method of forming a soft and durable wet laid tissue product comprising the steps of (a) providing a first fiber furnish consisting essentially of short wood pulp fibers and non-wood cellulosic fibers; (b) providing a second fiber furnish
15 consisting essentially of long wood pulp fibers; (c) depositing the first and second fiber furnish on a forming fabric to form a wet tissue web; (d) partially dewatering the wet tissue web; (e) drying the tissue web; and (f) converting the tissue web into a tissue product, wherein the product comprises from 5 to 30 weight percent non-wood cellulosic fiber and has a geometric mean tensile from about 500 to about 1,200 g/3" and a MD:CD Tensile ratio less than 2.0.

In a twentieth embodiment the present invention provides the method of the nineteenth
20 embodiment wherein the converting step comprises calendering, embossing, printing, or combinations thereof.

In a twenty-first embodiment the present invention provides the method of the nineteenth or twentieth embodiments further comprising the step of refining the second fiber furnish and wherein the
25 first fiber furnish is not refined.

WHAT IS CLAIMED IS:

1. A tissue product comprising at least one multi-layered tissue web comprising a first air contacting layer and a second fabric contacting layer, wherein the first air contacting layer comprises from about 5 to about 30 weight percent, by weight of the web, non-wood cellulosic fibers and the tissue
5 product has a geometric mean tensile from about 500 to about 1,200 g/3" and a MD:CD Tensile ratio less than about 2.0.
2. The tissue product of claim 1 wherein the fabric contacting layer is substantially free from non-wood cellulosic fiber.
3. The tissue product of claim 1 wherein the non-wood cellulosic fiber is derived from a
10 non-wood plant selected from the group consisting of *Hesperaloe funifera*, *Hesperaloe nocturna*, *Hesperaloe parviflora*, *Hesperaloe chiangii*, *Agave tequilana*, *Agave sisalana*, *Agave fourcroydes*, *Phyllostachys edulis*, *Bambusa vulgaris*, *Phyllostachys nigra* and combinations thereof.
4. The tissue product of claim 1 wherein the non-wood cellulosic has an average fiber length from about 1.0 to about 3.0 mm.
- 15 5. The tissue product of claim 1 having a GMT from about 700 to about 1,000 g/3" and a MD Slope from about 6.0 to about 10.0 kg.
6. The tissue product of claim 1 having a GMT from about 700 to about 1,000 g/3" and a Stiffness Index from about 6.0 to about 9.0.
7. The tissue product of claim 1 having a MD:CD slope ratio less than 2.0.
- 20 8. The tissue product of claim 1 having a GM Tear from about 12 to about 20 N.
9. The tissue product of claim 1 having a GM TEA from about 9.0 to about 12.0 g*cm/cm².
10. The tissue product of claim 1 having a MD:CD tensile ratio from about 1.5 to about 1.80.
11. The tissue product of claim 1 having a GMT from about 700 to about 1,000 g/3" and a GM Slope from about 6.0 to about 10.0 kg.
- 25 12. The tissue product of claim 1 wherein the non-wood cellulosic fiber is derived from a non-wood plant selected from *Phyllostachys edulis*, *Bambusa vulgaris*, *Phyllostachys nigra* and

combinations thereof and the non-wood cellulosic fiber has an average fiber length from about 1.2 to about 1.6 mm.

13. A tissue product comprising at least one multi-layered tissue web comprising a first and a second outer layer and a middle layer disposed therebetween, wherein the outer layers comprise from
5 about 5 to about 30 percent, by weight of the web, non-cellulosic fiber and the tissue product has a geometric mean tensile from about 500 to about 1,200 g/3" and a MD:CD Tensile ratio less than 2.0.

14. The tissue product of claim 13 wherein the middle layer is substantially free from non-wood cellulosic fiber.

15. The tissue product of claim 13 wherein the non-wood cellulosic fiber has an average
10 fiber length from about 1.0 to about 3.0 mm.

16. The tissue product of claim 13 having a MD:CD slope ratio from about 1.5 to about 1.75.

17. The tissue product of claim 13 having a GM Tear greater than about 12 N.

18. The tissue product of claim 13 having a GMT from about 700 to about 1,000 g/3" and a MD Slope from about 6.0 to about 10.0 kg.

15 19. A method of forming a soft and durable wet laid tissue product comprising the steps of:

- a. providing a first fiber furnish consisting essentially of short wood pulp fibers and non-wood cellulosic fibers;
- b. providing a second fiber furnish consisting essentially of long wood pulp fibers;
- c. depositing the first and second fiber furnish on a forming fabric to form a wet
20 tissue web;
- d. partially dewatering the wet tissue web;
- e. drying the tissue web; and
- f. converting the tissue web into a tissue product, wherein the product comprises from 5 to 30 weight percent non-wood cellulosic fiber and has a geometric mean tensile from
25 about 500 to about 1,200 g/3" and a MD:CD Tensile ratio less than 2.0.

20. The method of claim 19 wherein the converting step comprises calendering, embossing, printing, or combinations thereof.

21. The method of claim 19 wherein the non-wood cellulosic fiber is derived from a non-wood plant selected from the group consisting of *Hesperaloe funifera*, *Hesperaloe nocturna*, *Hesperaloe parviflora*, *Hesperaloe chiangii*, *Agave tequilana*, *Agave sisalana*, *Agave fourcroydes*, *Phyllostachys edulis*, *Bambusa vulgaris*, *Phyllostachys nigra* and combinations thereof.

5 22. The method of claim 21 wherein the non-wood cellulosic fiber has an average fiber length from about 1.0 to about 3.0 mm.

1/2

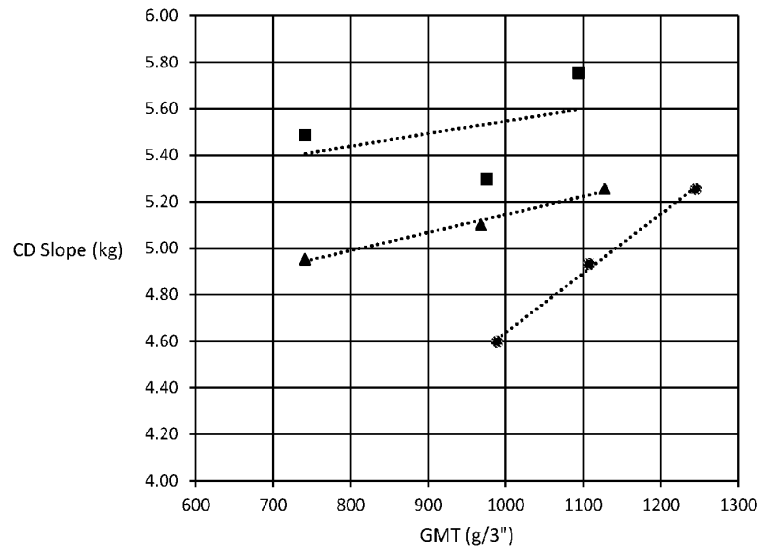


FIGURE 1

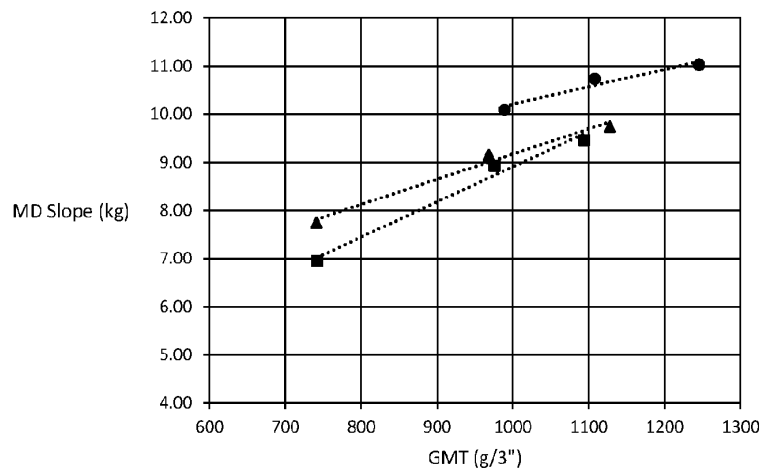


FIGURE 2

2/2

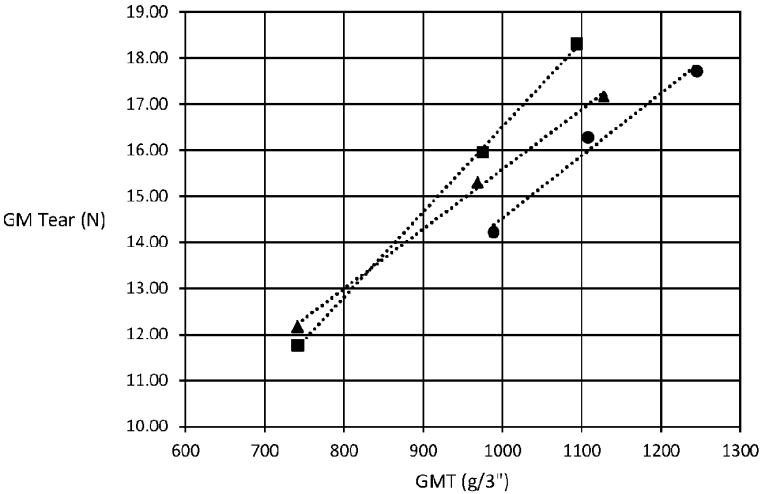


FIGURE 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/018822

A. CLASSIFICATION OF SUBJECT MATTER

D21H 11/12 (2006.01) D21F 11/04 (2006.01) A47K 10/16 (2006.01) D21H 27/00 (2006.01)

According to International Patent Classification (IPC)

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D21H, A47K

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)

EPODOC/WPIAP: layer, tissue, toilet and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014/200455 A1 (KIMBERLY-CLARK WORLDWIDE, INC.) 18 December 2014	1-2, 5-11, 13-14, 16-20
A	See samples 24-26 in tables 4-6, GMT values in table 5, MD tensile values in table 6, pg 12 line 5 - pg 13 line 13, pg 14 lines 4-14, pg 16 line 26 - pg 17 line 6 and pg 19 lines 8-31.	21
X	US 8574400 B1 (SHANNON, T. G. ET AL.) 5 November 2013 See sample 9 in Table 10 and 11, col 9 lines 7-67, col 10 lines 35-49, col 12 lines 21-39, col 12 lines 63-67 and col 20 line 45 - col 21 line 10, col 12 lines 63-67	1, 5-11, 13-14, 16-20
X	US 2013/0071678 A1 (SHANNON, T. G.) 21 March 2013 See [0052]-[0056], [0059], [0072], [0111], table 1, samples 9 and 10 in tables 3 and 6	1, 3-13, 15-18

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/018822

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2011/0168342 A1 (MOHAMMADI, K. P.) 14 July 2011 See table 1, [0139]-[0152]	1-2, 4-11, 13-20, 22
X	US 2016/0130762 A1 (RAMARATNAM, K. ET AL.) 12 May 2016 See [0084]-[0089]	1-2, 5-11, 13-20
X	US 2007/0011762 A1 (VINSON, K. D. ET AL.) 11 January 2007 See [0131]-[0142]	1-2, 5-11, 13-20
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A	CA 2076615 A1 (KIMBERLY-CLARK CORPORATION) 4 October 1993 See pg 3 lines 16-34, pg 15 line 35 – pg 16 line 9	
A	WO 2014/200456 A1 (KIMBERLY-CLARK WORLDWIDE, INC.) 18 December 2014 See sample 2 in tables 3-4, sample 8 in tables 8-10, pg 17 line 17 - pg 18 line 9	
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Form PCT/ISA/210 (continuation of second sheet (2)) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/US2017/018822

Note: This Annex lists known patent family members relating to the patent documents cited in this International Search Report. This Authority is in no way liable for these particulars which are merely given for the purpose of information.

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IP OFFICE TYPE	⚠			DE			112023001835			1) The Procter & Gamble Company, Cincinnati,				04/06/2023			US 63456020	DE 112023001835 T5		0
All IP5 Offices							Refresh Dossier										US PCT/US23/17660			
EP																	US 63329222			
CN																	US 63330077			
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US																	US 63456020	US 20230320541 A1		0
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										1) The Procter & Gamble Company,				04/06/2023			US 63353183	GB 202414689 D0		0
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																	US 63329718			
										1) The Procter & Gamble Company,				04/06/2023			US 63456020	GB 202414688 D0		0
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																	US 63330077			
																	US 63353183			
																	US 63329718			

 0	Office  0	Application  0	Assignee	Title  0	App. Date  0	Priority #	Pub. #  0
 0	US	18131387 View Dossier (details/US/18131387/A/95963) (/details/US/18131387/A/100169/true)	1) KIEN, KathrynChristian 2) YOUNG, ChristopherMichael 3) SHEEHAN, JeffreyGlen 4) OSTENDORF, WardWilliam	Sanitary Tissue Product Towels Comprising Non- wood Fibers	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718 US 18131387	US 20230323605 A1 0
	DE	112023001845 Refresh Dossier	1) The Procter & Gamble Company, Cincinnati,		04/06/2023	US 63456020 US PCT/US23/17659 US 63329222 US 63330077 US 63353183 US 63329718	DE 112023001845 T5 0
 0	US	18131384 View Dossier (details/US/18131384/A/78749) (/details/US/18131384/A/72709/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) KIEN, KathrynChristian 4) OSTENDORF, WardWilliam	Premium Sanitary Tissue Products Comprising Non- wood Fibers	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718 US 18131384	US 20240110336 A1 0
	DE	112023001829 Refresh Dossier	1) The Procter & Gamble Company, Cincinnati,		04/06/2023	US 63456020 US 63329222 US PCT/US23/17658 US 63330077 US 63353183 US 63329718	DE 112023001829 T5 0
 0	US	18131382 View Dossier (details/US/18131382/A/125627) (/details/US/18131382/A/97161/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) OSTENDORF, WardWilliam	Characteristics of Non-wood Fibers and the Sanitary Tissue Products Comprising Them	04/06/2023	US 63456020 US 63329222 US 18131382 US 63330077 US 63353183 US 63329718	US 20230320539 A1 0
 0	US	18131383 View Dossier (details/US/18131383/A/91100) (/details/US/18131383/A/107999/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) KIEN, KathrynChristian 4) OSTENDORF, WardWilliam	Soft Sanitary Tissue Products Comprising Non- wood Fibers	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718 US 18131383	US 20230323604 A1 0

 0	Office  0	Application  0	Assignee	Title  0	App. Date  0	Priority #	Pub. #  0
 0	US	18131381 View Dossier (details/US/18131381/A/123870) (/details/US/18131381/A/70490/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) KIEN, KathrynChristian 4) OSTENDORF, WardWilliam 5) WEISMAN, PaulThomas	Sanitary Tissue Products Comprising Non- wood Fibers and Having Improved Formation	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 18131381 US 63329718	US 20230323598 A1 0
 0	CA	3195408 View Dossier (details/CA/3195408/A/82524) (/details/CA/3195408/A/94815/true)	1) THE PROCTER & GAMBLE COMPANY,	SANITARY TISSUE PRODUCTS COMPRISING NON-WOOD FIBERS AND HAVING IMPROVED FORMATION	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	CA 3195408 A1 0
 0	US	PCT/US23/17660 View Dossier (details/US/PCTUS2317660/W/105997) (/details/US/PCTUS2317660/W/125351/true)	1) YOUNG, CHRISTOPHERMICHAEL 2) OSTENDORF, WARDWILLIAM 3) KIEN, KATHRYNCHRISTIAN 4) SHEEHAN, JEFFREYGLEN	SANITARY TISSUE PRODUCTS COMPRISING ONCE-DRIED FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	WO 2023196451 A1 0
 0	US	18131388 View Dossier (details/US/18131388/A/99198) (/details/US/18131388/A/111293/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) KIEN, KathrynChristian 4) OSTENDORF, WardWilliam	Sanitary Tissue Products Comprising Once- Dried Fibers	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 18131388 US 63329718	US 20230320540 A1 0
 0	CA	3195396 View Dossier (details/CA/3195396/A/109136) (/details/CA/3195396/A/102763/true)	1) THE PROCTER & GAMBLE COMPANY,	SANITARY TISSUE PRODUCT ROLLS COMPRISING NON-WOOD FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	CA 3195396 A1 0

 Office  Application 	Assignee	Title 	App. Date 	Priority #	Pub. # 
 CA 3195498 View Dossier (details/CA/3195498/A/100303) (/details/CA/3195498/A/93248/true)	1) THE PROCTER & GAMBLE COMPANY,	SANITARY TISSUE PRODUCT TOWELS COMPRISING NON-WOOD FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	CA 3195498 A1 
 US PCT/US23/17658 View Dossier (details/US/PCTUS2317658/W/82564) (/details/US/PCTUS2317658/W/81013/true)	1) YOUNG, CHRISTOPHERMICHAEL 2) OSTENDORF, WARDWILLIAM 3) KIEN, KATHRYNCHRISTIAN 4) SHEEHAN, JEFFREYGLEN	SOFT SANITARY TISSUE PRODUCTS COMPRISING NON-WOOD FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	WO 2023196449 A1 
 US PCT/US23/17659 View Dossier (details/US/PCTUS2317659/W/99283) (/details/US/PCTUS2317659/W/91657/true)	1) YOUNG, CHRISTOPHERMICHAEL 2) OSTENDORF, WARDWILLIAM 3) KIEN, KATHRYNCHRISTIAN 4) SHEEHAN, JEFFREYGLEN	PREMIUM SANITARY TISSUE PRODUCTS COMPRISING NON-WOOD FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	WO 2023196450 A1 
 CA 3195390 View Dossier (details/CA/3195390/A/116577) (/details/CA/3195390/A/126048/true)	1) THE PROCTER & GAMBLE COMPANY,	CHARACTERISTICS OF NON-WOOD FIBERS AND THE SANITARY TISSUE PRODUCTS COMPRISING THEM	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	CA 3195390 A1 
 GB 202414690 Refresh Dossier	1) The Procter & Gamble Company,		04/06/2023	US 63456020 US PCT/US23/17659GB 2631895 A  US 63329222 US 63330077 US 63353183 US 63329718	

 0	Office  0	Application  0	Assignee	Title  0	App. Date  0	Priority #	Pub. #  0
 0	US	18209510 View Dossier (details/US/18209510/A/101955) (/details/US/18209510/A/83800/true)	1) SCHWERTDFEGER, KatherineL. 2) FUNG, JoshuaThomas 3) SHEEHAN, JeffreyGlen 4) OTERO, Marlene 5) WEISMAN, PaulThomas 6) YOUNG, ChristopherM. 7) OSTENDORF, WardWilliam	ARRAYS COMPRISING HIGH TIER AND LOWER TIER SUSTAINABLE SANITARY TISSUE PRODUCTS	06/14/2023	US 63456020 US 63472379 US 63375858 US 18209510 US 63353183 US 63353167	US 20230404332 A1 0
 0	US	18209506 View Dossier (details/US/18209506/A/115843) (/details/US/18209506/A/115363/true)	1) SCHWERTDFEGER, KatherineL. 2) FUNG, JoshuaThomas 3) SHEEHAN, JeffreyGlen 4) OTERO, Marlene 5) WEISMAN, PaulThomas 6) YOUNG, ChristopherM. 7) OSTENDORF, WardWilliam 8) KIEN, KathrynChristian	ARRAYS OF SANITARY TISSUE PRODUCTS COMPRISING NON-WOOD(S)	06/14/2023	US 63456020 US 18209506 US 63472379 US 63375858 US 63353183 US 63353167	US 20230406608 A1 0
 0	US	18209509 View Dossier (details/US/18209509/A/126075) (/details/US/18209509/A/80925/true)	1) SCHWERTDFEGER, KatherineL. 2) FUNG, JoshuaThomas 3) SHEEHAN, JeffreyGlen 4) WEISMAN, PaulThomas 5) YOUNG, ChristopherM. 6) OSTENDORF, WardWilliam 7) KIEN, KathrynChristian	DIGITAL ARRAYS COMPRISING SUSTAINABLE SANITARY TISSUE PRODUCTS	06/14/2023	US 63456020 US 63472379 US 63375858 US 63353183 US 63353167 US 18209509	US 20230406610 A1 0

0	Office 0	Application 0	Assignee	Title 0	App. Date 0	Priority #	Pub. # 0
0	US	18209508	1) SCHWERTFEGER, KatherineL.	SANITARY TISSUE PRODUCT	06/14/2023	US 63456020	US 20230406609 A1 0
		View Dossier (details/US/18209508/A/113318) (/details/US/18209508/A/88147/true)	2) FUNG, JoshuaThomas	PACKAGES CONVEYING		US 18209508 US 63472379 US 63375858	
			3) SHEEHAN, JeffreyGlen	SUSTAINABILITY		US 63353183 US 63353167	
			4) OTERO, Marlene				
			5) WEISMAN, PaulThomas				
			6) YOUNG, ChristopherM.				
			7) OSTENDORF, WardWilliam				
			8) KIEN, KathrynChristian				
0	US	PCT/US23/68392	1) SCHWERTFEGER, KATHERINEL.	SANITARY TISSUE PRODUCT	06/14/2023	US 63456020	WO 2023245028 A1 0
		View Dossier (details/US/PCTUS2368392/W/89593) (/details/US/PCTUS2368392/W/118560/true)	2) FUNG, JOSHUA THOMAS	PACKAGES CONVEYING		US 63472379 US 63375858 US 63353183	
			3) OTERO, MARLENE	SUSTAINABILITY		US 63353167	
			4) KIEN, KATHRYNCHRISTIAN				
			5) WEISMAN, PAULTOMAS				
			6) YOUNG, CHRISTOPHERM.				
			7) OSTENDORF, WARDWILLIAM				
			8) SHEEHAN, JEFFREYGLEN				
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Receipt date: 07/17/2025

18/131,383 - GAU: 1748

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-25)

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	Filing Date		2023-04-06	
	First Named Inventor	YOUNG Christopher Michael (YOUNG/CM)		
	Art Unit	1748		
	Examiner Name	JOSE A FORTUNA		
	Attorney Docket Number	--16255M3-US		

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Inventor of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	8343625	B2	2013-01-01	Mackey, Larry Neil et al.	
	2	8715826	B2	2014-05-06	Mackey, Larry Neil et al.	

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Kimberly Clark EX1002, p. 4584
PGR2026-00078

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	18131383
	Filing Date	2023-04-06
	First Named Inventor	YOUNG Christopher Michael (YOUNG/CM)
	Art Unit	1748
	Examiner Name	JOSE A FORTUNA
	Attorney Docket Number	--16255M3-US

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Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L21	1251	((("YOUNG") near3 ("Christopher")) OR ((("SHEEHAN") near3 ("Jeffrey")) OR ((("KIEN") near3 ("Kathryn")) OR ((("OSTENDORF") near3 ("Ward")))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2025/07/21 04:17 PM
L22	81498	(D21H27/005 or A47K10/16 or D21H11/12 or D21H17/26 or D21H21/10 or D21H21/20 or D21H27/002 or D21H27/004 or D21H27/02 or D21H27/30 or D21H27/40 or D21H27/38).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/07/21 04:17 PM
L23	35	(tissue towel wipe non\$wove non ADJ woven sheet web) WITH (bamboo abaca) AND (TS7 TS750)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/07/21 04:17 PM
L24	145	("10227729" OR "10731301" OR "10954417" OR "11097881" OR "11124357" OR "20080110783" OR "20080202954" OR "20090056891" OR "20090194435" OR "20090311660" OR "20090311661" OR	(US-PGPUB; USPAT)	OR	ON	ON	2025/07/21 04:17 PM

		"20160038353" OR "20160051422" OR "20180230344" OR "20210087748" OR "20210285156" OR "20220356648" OR "6926149" OR "7172073" OR "8197455" OR "8961739" OR "9242775" OR "9327888" OR "10132036" OR "10145069" OR "10337149" OR "10428465" OR "10550522" OR "20020096287" OR "20020134520" OR "20020148574" OR "20020148584" OR "20030111197" OR "20030121629" OR "20030192662" OR "20030196772" OR "20040084165" OR "20040140076" OR "20040168780" OR "20040194901" OR "20040226673" OR "20050236122" OR "20050238682" OR "20060288639" OR "20070011762" OR "20070051484" OR "20070107863" OR "20070298995" OR "20080008853" OR "20080202968" OR "20090068633" OR "20090266500" OR "20090297781" OR "20100032113" OR "20100043989" OR "20100126685" OR "20110017631" OR "20110168342" OR "20110297343" OR "20110303375" OR "20120018964" OR "20120247696" OR "20130068867" OR "20130068868" OR "20130071655" OR "20130071678" OR "20130199741" OR "20130269892" OR "20130299107" OR				
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		"20130312924" OR "20140044883" OR "20140093704" OR "20140093705" OR "20140205777" OR "20140284010" OR "20150129143" OR "20150144280" OR "20160130762" OR "20160138224" OR "20160145809" OR "20160304818" OR "20160355987" OR "20170254025" OR "20180030654" OR "20180044859" OR "20180135248" OR "20180135249" OR "20180142419" OR "20180142420" OR "20180142421" OR "20190100878" OR "20190100883" OR "20190169798" OR "20190249367" OR "20190264395" OR "20190276985" OR "20200040529" OR "20200102705" OR "20200115853" OR "20200129013" OR "20200131707" OR "20200232166" OR "20210237964" OR "20210332531" OR "20220010495" OR "20230320539" OR "20230320540" OR "20230320541" OR "20230323598" OR "20230323605" OR "3004884" OR "3994771" OR "4300981" OR "4464224" OR "4857145" OR "5320710" OR "5348620" OR "5472569" OR "5607551" OR "5656132" OR "5932068" OR "6171442" OR "6174412" OR "6248211" OR "6258207" OR "6302997" OR "6455129" OR					
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L25	163	"6511579" OR "6709550" OR "6796114" OR "6797114" OR "6821387" OR "6931313" OR "7156954" OR "7166190" OR "7682488" OR "8049060" OR "8524374" OR "8574400" OR "8741104" OR "8742181" OR "8778505" OR "9222224" OR "9410291" OR "9447545").pn. ((tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 TS750))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/07/21 04:17 PM
L26	100	5 AND @PD<"2022"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/07/21 04:17 PM
L27	73	6 AND 2	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2025/07/21 04:17 PM

L28	39	6 AND 2	IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/07/21 04:17 PM
L29	5	("4793898" "4594130" "3585104" "5595628").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/07/21 04:17 PM
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L33	15	(toilet bath) near2 tissue WITH TS750	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/07/21 04:17 PM
L34	19	(toilet bath) near2 tissue SAME TS750	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/07/21 04:17 PM

L35	44	15 NOT 14	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/07/21 04:17 PM
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L43	1	("20190366676").pn.	(US-PGPUB)	OR	ON	ON	2025/07/21 04:55 PM

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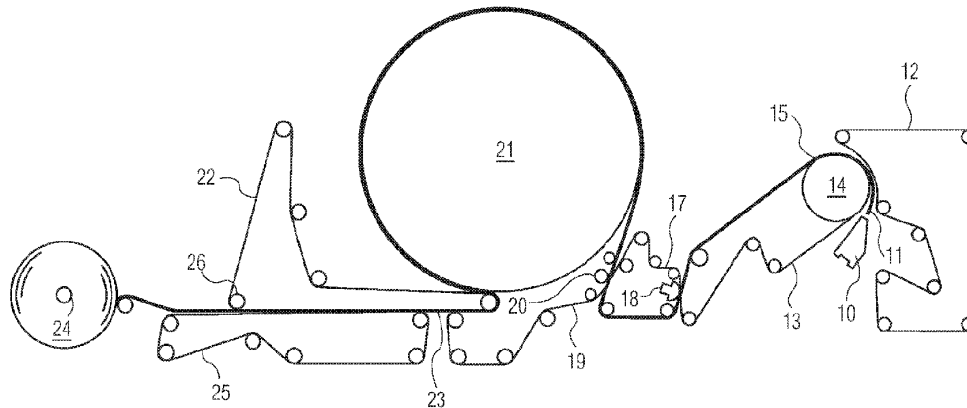


FIG. 1

(57) Abstract: A tissue sheet includes softwood fibers and treated non-wood fibers from plants in the *Poaceae* family, wherein the treated non-wood fibers have less than 15 percent hemicellulose. Also, a tissue sheet consists essentially of softwood fibers and treated non-wood fibers, wherein the treated non-wood fibers have less than 15 percent hemicellulose. Customizing the tensile index and Canadian standard freeness (CSF) of fibers in a tissue sheet includes treating non-wood fibers by removing a portion of hemicellulose from the non-wood fibers; forming a tissue sheet comprising softwood fibers and the treated non-wood fibers; and adjusting the portion of hemicellulose removed from the non-wood fibers to achieve a desired the tensile index and Canadian standard freeness (CSF) of the treated non-wood fibers.

[Continued on next page]

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TAILORED HEMICELLULOSE IN NON-WOOD FIBERS FOR TISSUE PRODUCTS**BACKGROUND**

5 The present disclosure relates to the use of non-wood alternative natural fibers in tissue products. A replacement of the conventional hardwood fiber is achieved by a hybrid fibrous composition that provides sufficient mechanical strength for tissue applications.

Tissue products, such as facial tissues, paper towels, bath tissues, napkins, and other similar products, are designed to include several important properties. For example, the products should have good bulk, a soft feel, and should have good strength and
10 durability. When steps are taken to increase one property of the product, however, other characteristics of the product are often adversely affected.

Tissue products are made via one of two primary tissue manufacturing processes: conventional wet press (CWP) and through-air drying (TAD). In CWP, the tissue is formed on a forming fabric from either a suction breast roll or twin wire former and the embryonic
15 web is transferred to a papermaking felt and dewatered by pressing with one or two pressure roll nips against the surface of a large steam heated cylinder called a Yankee dryer. The pressing process also assists in transfer of the sheet to the Yankee dryer surface. An adhesive solution is sprayed on the dryer surface prior to the sheet transfer in order to provide good bonding between the sheet and the dryer surface. The sheet is
20 removed from the Yankee surface by a doctor blade in the creping process.

In the TAD process, the sheet is formed on a forming fabric and transferred to one or more other fabrics as it is dewatered to a consistency of 25 percent or higher. After the initial dewatering the sheet is dried while in contact with the fabric by blowing hot air through the fabric. In conventional through-air dried processes, the through-air dried web
25 is adhered to a Yankee dryer and creped. A roll may be present at the point of transfer to assist in the transfer of the web from the drying fabric to the Yankee dryer but absent the presence of high pressure used to dewater the web in the CWP process. Alternatively TAD tissue may be prepared without creping where foreshortening of the web occurs with a differential velocity transfer of the wet laid web from the forming fabric to a substantially
30 slower moving, open mesh transfer fabric. Thereafter the web is dried while preventing macroscopic rearrangement of the fibers in the plane of the web. The web is then dried on a fabric in the through-air dryer to a consistency of 90 percent or higher and wound. No Yankee dryer is used in the uncreped through-air dried (UCTAD) process. Through-air dried tissue products are typically associated with higher quality tier tissue products than

conventional wet pressed products due to their higher bulk and greater absorption capacity.

To achieve the optimum product properties, tissue products are typically formed, at least in part, from pulps containing wood fibers and often a blend of hardwood and softwood fibers to achieve the desired properties. Typically when attempting to optimize surface softness, as is often the case with tissue products, the papermaker will select the fiber furnish based in part on the coarseness of pulp fibers. Pulps having fibers with low coarseness are desirable because tissue paper made from fibers having a low coarseness can be made softer than similar tissue paper made from fibers having a high coarseness. To optimize surface softness even further, premium tissue products usually include layered structures where the low coarseness fibers are directed to the outside layer of the tissue sheet with the inner layer of the sheet including longer, coarser fibers.

This need for softness is balanced or perhaps opposed by the need for durability. Durability in tissue products can be defined in terms of tensile strength, tensile energy absorption (TEA), burst strength, and tear strength. Typically tear, burst, and TEA will show a positive correlation with tensile strength while tensile strength, and thus durability, and softness are inversely related. Thus the paper maker is continuously challenged with the need to balance the need for softness with a need for durability. Unfortunately, tissue paper durability generally decreases as the average fiber length is reduced. Therefore, simply reducing the pulp average fiber length can result in an undesirable trade-off between product surface softness and product durability.

The tissue papermaker who is able to obtain pulps having a desirable combination of fiber length and coarseness from fiber blends generally regarded as inferior with respect to average fiber properties may reap significant cost savings and/or product improvements. For example, the papermaker may wish to make a tissue paper of superior strength without incurring the usual degradation in softness which accompanies higher strength. Alternatively, the papermaker may wish a higher degree of paper surface bonding to reduce the release of free fibers without suffering the usual decrease in softness which accompanies greater bonding of surface fibers. As such, a need currently exists for a tissue product formed from a fiber that will improve durability without negatively affecting other important product properties, such as softness.

Outside of Northern and Southern softwood pulp fibers very few options exist for papermakers when selecting long fibers.

A major problem affecting pulp and paper industries worldwide is the increasing cost of suitable wood fiber resulting from concerns about competing uses for forest lands,

environmental impact of forest operations, and sustainable forest management. Consequently, the tissue industry is always searching for alternative low-cost fiber species for sustainable manufacturing. Also, environmental groups and consumers who prefer to use green products have advocated for the use of non-wood fibers as being more environmentally friendly than wood fibers. In order to reduce the reliance on commodity wood pulp, the use of recycled fibers can be a partial solution, but the use of recycled fibers in tissue sheets is technically limited by the end product quality acceptable to users.

Previous approaches rely on tree-based fibers. The ability to use fibrous feedstock that grows in a shorter lifecycle and to use residuals from agricultural or industrial processing can help to fulfill corporate sustainability goals and reduce environmental impact on forests as well as carbon footprint (measured in eCO₂ units).

Pulping processes for non-wood natural fibers are raw-material-dependent. Detailed steps can be found in Sridach, W. (2010), The Environmentally Benign Pulping Process of Non-wood Fibers, Suranaree J. Sci. Technol., 17(2), 105-123, and U.S. Patent No. 6,302,997 B1 to Hurter and Byrd. Alternative non-wood natural fibers such as field crop fibers or agricultural residues are considered more sustainable. Examples of those raw natural materials include miscanthus, soybean stalks, kenaf, flax, bamboo, cotton stalks, sugar cane bagasse, corn stover, rice straw, oat straw, wheat straw, switchgrass, sorghum, reed, arundo donax, other members of the *Poaceae* family, also known as the *Gramineae* family, and combinations thereof. Non-wood fiber sources account for about 5-10% of global pulp production, for a variety of reasons, including seasonal availability, problems with chemical recovery, brightness of the pulp, silica content, etc. Particularly attractive are corn stover and wheat straw as sources for pulp due to their global abundance. Non-wood fibers provide an option for product manufacturers to explore to add a green component into their final products.

Therefore, there exists a need for providing wood-alternative pulp materials to replace conventional fiber materials used in tissue. As a result, the present disclosure fills such gaps by providing wood-alternative materials that can be used for environmentally-sustainable tissue.

SUMMARY

Generally, dry paper products, and particularly dry tissue substrates, including a blend of conventional papermaking fibers and non-wood fibers are disclosed herein.

The present disclosure is directed to a tissue sheet including softwood fibers and treated non-wood fibers from plants in the *Poaceae* family, wherein the treated non-wood

fibers have less than 15 percent hemicellulose. The non-wood fibers can be selected from corn stover, straw, other land-based natural fibers, and combinations thereof. The straw can be selected from the group consisting of wheat, rice, oat, barley, rye, flax, grass, soybeans, and combinations thereof. The other land-based natural fibers are selected
5 from flax, bamboo, cotton, jute, hemp, sisal, bagasse, kenaf, switchgrass, miscanthus, and combinations thereof.

The present disclosure is also directed to a tissue sheet consisting essentially of softwood fibers and treated non-wood fibers, wherein the treated non-wood fibers have less than 15 percent hemicellulose.

10 The present disclosure is also directed to a method for customizing the tensile index and Canadian standard freeness (CSF) of fibers in a tissue sheet, the method including treating non-wood fibers by removing a portion of hemicellulose from the non-wood fibers; forming a tissue sheet comprising softwood fibers and the treated non-wood fibers; and adjusting the portion of hemicellulose removed from the non-wood fibers to
15 achieve a desired the tensile index and Canadian standard freeness (CSF) of the treated non-wood fibers.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features and aspects of the present disclosure and the
20 manner of attaining them will become more apparent, and the disclosure itself will be better understood by reference to the following description, appended claims and accompanying drawings, where:

Figure 1 is a schematic diagram of one aspect of a process for forming an uncreped through-air dried tissue web for use in the present disclosure; and

25 Figure 2 is a graphical illustration of the relationship between Tensile Index and CSF for various non-wood fibers.

Repeat use of reference characters in the present specification and drawings is intended to represent the same or analogous features or elements of the present disclosure. The drawings are representational and are not necessarily drawn to scale.
30 Certain proportions thereof might be exaggerated, while others might be minimized.

DETAILED DESCRIPTION

While the specification concludes with the claims particularly pointing out and distinctly claiming the disclosure, it is believed that the present disclosure will be better understood from the following description.

5 As used herein, "comprising" means that other steps and other ingredients that do not affect the end result can be added. This term encompasses the terms "consisting of" and "consisting essentially of." The compositions and methods/processes of the present disclosure can comprise, consist of, and consist essentially of the essential elements and limitations of the disclosure described herein, as well as any of the additional or optional
10 ingredients, components, steps, or limitations described herein.

As used herein, the terms "non-wood," "tree-free," and "wood alternative" generally refer to processing residuals from agricultural crops such as wheat straw and wetland non-tree plants such as bulrush. Examples of non-wood natural materials of the present disclosure include, but are not limited to, miscanthus, soybean stalks, kenaf, flax, bamboo,
15 cotton stalks, sugar cane bagasse, corn stover, rice straw, oat straw, wheat straw, switchgrass, sorghum, reed, arundo donax, other members of the *Poaceae* family, also known as the *Gramineae* family, and combinations thereof.

As used herein, the term "pulp" or "pulp fiber" refers to fibrous material obtained through conventional pulping processes known in the arts. This can be for woody and
20 non-woody materials.

As used herein, the term "fines" refer to the fraction that passes through a 200 mesh screen (75 μ m). The median size of fines is a few microns. Fines consist of cellulose, hemicellulose, lignin, and extractives. There are two types of the fines: primary and secondary fines. The primary fines content seems to be a genetic characteristic of
25 the plant. Eucalyptus pulp is approximately 4%, while other hardwood pulps can be up to about 20% to about 40%. Wheat straw is typically about 38% to about 50%. The secondary fines are pieces of fibrils from the outer layers of fibers that are broken off during refining.

As used herein, the term "basis weight" generally refers to the weight per unit area
30 of paperboard. Basis weight is measured herein using TAPPI test method T-220. A sheet of pulp, commonly 30 cm x 30 cm or of another convenient dimension is weighed and then dried to determine the solids content. The area of the sheet is then determined and the ratio of the dried weight to the sheet area is reported as the basis weight in grams per square meter (gsm).

As used herein, the term "Tear Index" refers to the quotient of the geometric mean tear strength (typically expressed in grams) divided by the geometric mean tensile strength (typically expressed in grams per 3 inches) multiplied by 1,000 where the geometric mean tear index is defined as the square root of the product of the machine

5 directional tear strength and the cross directional tear strength.

$$Tear\ Index = \frac{\sqrt{MD\ Tear \times CD\ Tear}}{GMT} \times 1,000$$

While tear index may vary depending on the composition of the tissue web, as well as the basis weight of the web, webs prepared according to the present disclosure generally have a Tear Index greater than about 5, more preferably greater than about 6 and still

10 more preferably greater than about 7 such as from about 7 to about 20.

As used herein, the term "Burst Index" refers to the quotient of the dry burst peak load (also referred to as the dry burst strength and typically expressed gram feet) divided by the geometric mean tensile strength multiplied by 10.

$$Burst\ Index = \frac{Dry\ Burst\ Strength}{GMT} \times 10$$

15 While Burst Index may vary depending on the composition of the tissue web, as well as the basis weight of the web, webs prepared according to the present disclosure generally have a burst index greater than 3, more preferably greater than about 4 and still more preferably greater than about 5.

As used herein, the terms "geometric mean tensile" and "GMT" refer to the square

20 root of the product of the machine direction tensile strength and the cross-machine direction tensile strength of the web. As used herein, tensile strength refers to geometric mean tensile strength as would be apparent to one skilled in the art unless otherwise stated.

As used herein, the terms "geometric mean tensile energy index" and "TEA Index"

25 refer to the square root of the product of the MD and CD tensile energy absorption ("MD TEA" and "CD TEA," typically expressed in g•cm/cm²) divided by the GMT strength multiplied by 1,000.

$$TEA\ Index = \frac{\sqrt{MD\ TEA \times CD\ TEA}}{GMT} \times 1,000$$

While the TEA Index may vary depending on the composition of the tissue web, as well as

30 the basis weight of the web, webs prepared according to the present disclosure generally

have a TEA Index greater than about 6, more preferably greater than about 7 and still more preferably greater than about 8, such as from about 8 to about 20.

As used herein, the term "Durability Index" refers to the sum of the tear index, burst index and TEA Index and is an indication of the durability of the product at a given tensile strength.

$$\text{Durability Index} = \text{Tear Index} + \text{Burst Index} + \text{TEA Index}$$

While the Durability Index may vary depending on the composition of the tissue web, as well as the basis weight of the web, webs prepared according to the present disclosure generally have a Durability Index values of about 15 or greater, more preferably about 18 or greater and still more preferably about 20 or greater such as from about 20 to about 50.

As used herein, the term "Stiffness Index" refers to the quotient of the geometric mean tensile slope, defined as the square root of the product of the MD and CD tensile slopes, divided by the geometric mean tensile strength.

$$\text{Stiffness Index} = \frac{\sqrt{\text{MD Tensile Slope} \times \text{CD Tensile Slope}}}{\text{GMT}} \times 1,000$$

While the Stiffness Index may vary depending on the composition of the tissue web, as well as the basis weight of the web, webs prepared according to the present disclosure generally have a Stiffness Index values of less than about 16, more preferably less than about 15 and still more preferably less than about 14 such as from about 5 to about 14.

As used herein, the term "average fiber length" refers to the length weighted average length of fibers determined utilizing a Kajaani fiber analyzer model No. FS-100 available from Kajaani Oy Electronics, Kajaani, Finland. According to the test procedure, a pulp sample is treated with a macerating liquid to ensure that no fiber bundles or shives are present. Each pulp sample is disintegrated into hot water and diluted to an approximately 0.001 percent solution. Individual test samples are drawn in approximately 50 to 100 ml portions from the dilute solution when tested using the standard Kajaani fiber analysis test procedure. The weighted average fiber length may be expressed by the following equation:

$$\sum_{x_i=0}^k (x_i \times n_i) / n$$

where k = maximum fiber length

xi = fiber length

ni = number of fibers having length xi

n = total number of fibers measured.

As used herein, a "tissue product" generally refers to various paper products, such as facial tissue, bath tissue, paper towels, napkins, and the like. Normally, the basis weight of a tissue product of the present disclosure is less than about 80 grams per square meter (gsm), in some aspects less than about 60 gsm, and in some aspects, between about 10 to about 60 gsm.

Tissue products are further differentiated from other paper products in terms of their bulk. The bulk of the tissue and towel products of the present disclosure is calculated as the quotient of the caliper (hereinafter defined), expressed in microns, divided by the basis weight, expressed in grams per square meter. The resulting bulk is expressed as cubic centimeters per gram. In various examples tissue products can have a bulk greater than about 5 cm³/g and still more preferably greater than about 7 cm³/g, such as from about 7 to about 15 cm³/g. Tissue webs prepared according to the present disclosure can have higher bulk than the tissue products incorporating the same webs. For example, tissue webs may have a bulk greater than about 7 cm³/g, such as greater than about 10 cm³/g, such as from about 12 to about 24 cm³/g.

As used herein, the term "layer" refers to a plurality of strata of fibers, chemical treatments, or the like within a ply.

The term "ply" refers to a discrete product element. Individual plies may be arranged in juxtaposition to each other. The term may refer to a plurality of web-like components such as in a multi-ply facial tissue, bath tissue, paper towel, wipe, or napkin.

As used herein, the terms "layered tissue web," "multi-layered tissue web," "multi-layered web," and "multi-layered paper sheet," generally refer to sheets of paper prepared from two or more layers of aqueous papermaking furnish which are preferably included of different fiber types. The layers are preferably formed from the deposition of separate streams of dilute fiber slurries, upon one or more endless foraminous screens. If the individual layers are initially formed on separate foraminous screens, the layers are subsequently combined (while wet) to form a layered composite web.

As used herein the term "web-forming apparatus" generally includes fourdrinier former, twin wire former, cylinder machine, press former, crescent former, and the like, known to those skilled in the arts.

As used herein the term "Canadian standard freeness" (CSF) refers generally to the rate at which slurry of fibers drains and is measured as described in TAPPI standard test method T 227 OM-09. The unit for the CSF is mL.

Table 1 compares hardwood (eucalyptus pulp fiber, Aracruz Cellulose, Brazil) and softwood (NSWK pulp fiber, Northern Pulp, Canada).

TABLE 1

Fiber Type	Average Fiber Length (mm)	Average Fiber Width (μm)	Fiber Length: Fiber Width	Coarseness (mg/100 m)
NSWK Pulp Fiber	2.18	27.6	79	14.83
Eucalyptus Pulp Fiber	0.76	19.1	40	8.95

5 The present disclosure describes the use of non-wood fibers to replace a portion of the virgin wood fiber in at least one of the layers. As described above, however, the tradeoff between softness and strength/durability must be considered. The present disclosure describes how tensile strength can be decreased and softness increased in non-wood fibers by managing the level of hemicellulose in the non-wood fibers. This also
10 increases the Canadian Standard Freeness (CSF) and decreases their Water Retention Value (WRV) and their coarseness. The treated non-wood fibers replace a portion of the eucalyptus fibers in the tissue sheet while increasing durability (increased tear and burst strength) of the tissue sheet.

Typical tissue furnishing includes both long (northern bleached softwood kraft
15 (NBSK)) and short (eucalyptus) fibers. Long fiber provides strength and durability while short fiber provides softness. Comparing agricultural pulp morphology with NBSK and eucalyptus in one example, the length-weighted average fiber length of corn stover (> 0.8 mm) and wheat straw (< 1 mm) pulps are much shorter than NBSK (2.23 mm) but longer than that of eucalyptus. For this reason, because fiber from corn stover and wheat straw
20 can be used to produce an equivalent softness of eucalyptus, the products made are more durable due to the longer fiber length.

It is commonly observed that non-wood pulps have higher tensile index, lower freeness, and higher water retention value (WRV) than those of wood pulps with similar fiber length. The shorter fiber length of these pulps precludes full replacement of NBSK
25 without a significant quality loss. As a replacement for eucalyptus, many non-wood fibers such as wheat and corn offer advantages over eucalyptus due to their longer fiber length. For example, higher burst and tear strengths would be expected. However, such pulps are generally not suitable for the replacement of eucalyptus due to their high tensile strength which results in lower product softness. While it is possible to use debonders to
30 reduce the tensile strength, the use of debonders significantly increases cost as well as slough and lint in the product. To enable non-wood pulps to replace eucalyptus pulps, there is a need to reduce the tensile index with these non-wood pulps without the use of chemical debonders.

In one aspect, the present disclosure yields soft and durable tissue products including cellulosic fibers from agricultural residues such as corn, switchgrass, and wheat, wherein these cellulosic fibers have had a portion of hemicellulose removed. In another aspect, the present disclosure provides a method of making soft and durable tissue products including cellulosic fibers from agricultural residues, where the method includes replacing all or a portion of short wood fibers in the product with cellulosic fibers from agricultural residues, where the cellulosic fibers from agricultural residues have had all or a portion of hemicellulose removed.

In addition, purpose-grown fiber crops can also be used to provide fiber for the process described herein. These can include miscanthus, switchgrass, soybean stalks, cotton stalks, and the like and can be grown near or with agricultural residue crops such as corn, wheat, soybeans, sorghum, etc. Some of these purpose-grown crops are in the *Poaceae* family, but others are not yet still provide useful fiber.

Treated non-wood fibers can be selected for use based on fiber length. To replace eucalyptus fibers it can be useful to select fibers having a length weighted average fiber length less than about 1.1 mm such that they are similar to the eucalyptus fibers.

Removing hemicellulose in fibers reduces their tensile index and increases freeness, and is used in dissolving cellulose. The process described herein controls the amount of hemicellulose removed because removing all the hemicellulose such as in dissolving grade cellulose flattens the refining curve and significantly reduces the tensile strength necessary in high-strength applications such as toweling.

In still another aspect the present disclosure provides for tailoring hemicellulose levels to adjust and control tensile index, CSF, and water retention value to improve product softness with non-wood pulps and to improve runability. In yet another aspect the disclosure relates to a method for preparing pulp suitable for tissue making from more than one type of non-wood agricultural residue biomass wherein the level of hemicellulose in the pulps is controlled such that the tensile index and CSF of the resulting unrefined pulps are about equal. This ability to tailor to a tensile index/CSF profile by controlling hemicellulose level enables a biorefinery to run agriculture residuals of various types and purpose-grown biomasses with similar fiber properties throughout the year according to their seasonality and availability. The resulting fibers can have nearly identical properties regardless of fiber source. Because the quality (i.e., tensile index at a given freeness) of such pulps is largely equivalent, the agricultural biorefinery and the tissue-making process can run longer and with less risk of interruption or quality issues than if a single crop is relied upon. Thus there is a need to find a means to control the quality and properties of

different fibers such that the freeness and tensile index of the different fibers are equivalent.

Use of alternative non-wood natural fibers such as using field crop fibers and agricultural residues instead of wood fibers is considered more sustainable, due in part to the classification of these materials as by-products of or waste from other processes. Suppliers can pay customers to help them dispose of these materials. Examples of such raw natural materials are bagasse, corn stover, rice straw, oat straw, and wheat straw. Non-wood fiber sources account for only about 5-10% of global pulp production for a variety of reasons including seasonal availability, problems with chemical recovery, brightness of the pulp, silica content, etc.

The present disclosure describes using at least one non-wood or tree-free alternative pulp material in tissue products to replace a portion of conventional fiber materials. The composition of the present disclosure includes at least one non-wood alternative pulp material selected from natural fibers, and combinations thereof. Land-based natural fibers can include flax, cotton stalks, bagasse, kenaf, switchgrass, miscanthus, and combinations thereof. Individual fibrous material from those non-wood materials can be derived from conventional pulping processes such as thermal mechanical pulping, kraft pulping, chemical pulping, enzyme-assisted biological pulping or organosolv pulping known in the art.

The pulp material compositions of the present disclosure can include various amounts of non-wood alternative natural pulp fibers. The composition can have a combination of elements where there is at least one non-wood alternative natural pulp fiber alone or it can be combined with a wood pulp fiber. For example, the amount of non-wood alternative natural pulp fibers of the present disclosure can be present in an amount of from about 5%, from about 10%, from about 20%, from about 25%, from about 30% to about 40%, to about 50%, to about 60%, to about 75%, to about 100% by weight of the composition. The pulp material compositions of the present disclosure can also include a hardwood, short fiber pulp in an amount of from about 5%, from about 10%, from about 20%, or from about 30%, to about 40%, to about 50%, to about 60% or to about 70%, by weight of the composition. When the non-wood alternative pulp materials are present alone, in combination with each other or in combination with a wood pulp fiber, the composition can then be used for a tissue product that replaces a portion of conventional fiber materials.

Accordingly, in a preferred aspect the disclosure provides a tissue web and more preferably a through-air dried tissue web and still more preferably a multi-layered through-air dried web including non-wood fibers, wherein the non-wood fibers include at least

about 10 percent of the total weight of the web. In a particularly preferred aspect, the tissue web includes a multi-layered through-air dried web wherein non-wood fiber is selectively disposed in only one of the layers such that the non-wood fiber is not brought into contact with the user's skin in-use. For example, in one aspect the tissue web may

5 include a two layered web wherein the first layer consists essentially of wood fibers and is substantially free of non-wood fibers and the second layer includes non-wood fibers, wherein the non-wood fibers includes at least about 50 percent by weight of the second layer, such as from about 50 to about 100 percent by weight of the second layer. It should be understood that, when referring to a layer that is substantially free of non-wood fibers,

10 negligible amounts of the fibers may be present therein, however, such small amounts often arise from the non-wood fibers applied to an adjacent layer, and do not typically substantially affect the softness or other physical characteristics of the web.

The tissue webs may be incorporated into tissue products that may be either single or multi-ply, where one or more of the plies may be formed by a multi-layered tissue web

15 having non-wood fibers selectively incorporated in one of its layers. A particularly preferred aspect tissue product is constructed such that the non-wood fibers are not brought into contact with the user's skin in-use. For example, the tissue product may include two multi-layered through-air dried webs wherein each web includes a first fibrous layer substantially free from non-wood fibers and a second fibrous layer including non-

20 wood fibers. The webs are plied together such that the outer surface of the tissue product is formed from the first fibrous layers of each web, such that the surface brought into contact with the user's skin in-use is substantially free of non-wood fibers.

Non-wood fiber for use in the webs and products of the present disclosure may be produced by any appropriate methods known in the art. Preferably the non-wood fibers

25 are pulped non-wood fibers, produced by chemical processing of crushed non-wood material. The chemical processing may include treating the crushed non-wood material with an appropriate alkaline solution. The skilled artisan will be capable of selecting an appropriate alkaline solution. Non-wood fiber may also be produced by mechanical processing of crushed non-wood material, which may involve enzymatic digestion of the

30 crushed non-wood material.

Pulp fibers can be prepared in high-yield or low-yield forms and can be pulped in any known method, including kraft, sulfite, high-yield pulping methods and other known pulping methods. Fibers prepared from organosolv pulping methods can also be used, including the fibers and methods disclosed in U.S. Patent No. 4,793,898 issued December

35 27, 1988 to Laamanen et al.; U.S. Patent No. 4,594,130 issued June 10, 1986 to Chang et al.; and U.S. Patent No. 3,585,104 issued June 15, 1971 to Kleinert. Useful fibers can

also be produced by anthraquinone pulping, exemplified by U.S. Patent No. 5,595,628 issued January 21, 1997 to Gordon et al.

Although non-wood fiber may be produced by any appropriate method known in the art, the preferred method for manufacturing the non-wood pulp is as a chemical
5 pulping method such as, but not limited to, kraft, sulfite, or soda/AQ pulping techniques.

Reducing the level of hemicellulose in non-wood fibers can also be accomplished by any appropriate method known in the art, including the enzymatic process described in U.S. Patent Application Publication No. 2013/0217868 to Fackler et al., although in the present disclosure the removal of hemicellulose must be controlled to avoid degrading
10 cellulose, which is the typical goal of such processes. Enzymes such as those classified as xylanase and/or cellulase can be used although these can degrade cellulose.

In general, the tissue sheet may be formed using any suitable papermaking techniques. For example, a papermaking process can utilize creping, wet creping, double creping, embossing, wet pressing, air pressing, through-air drying, creped through-air
15 drying, uncreped through-air drying, hydroentangling, air laying, as well as other methods known in the art.

One such exemplary technique will be hereinafter described. Desirably, the tissue sheet is a through-air dried tissue basesheet. Exemplary processes to prepare uncreped through-air dried tissue are described in U.S. Patent No. 5,607,551, U.S. Patent No.
20 5,672,248, U.S. Patent No. 5,593,545, U.S. Patent No. 6,083,346 and U.S. Patent No. 7,056,572, all herein incorporated by reference to the extent they do not conflict herewith.

Fig. 1 illustrates a machine for carrying out the method of forming the multi-layered tissue defined herein. For simplicity, the various tensioning rolls schematically used to define the several fabric runs are shown but not numbered. It will be appreciated that
25 variations from the apparatus and method illustrated in Fig. 1 can be made without departing from the scope of the claims. Shown is a twin wire former having a layered papermaking headbox 10 which injects or deposits a stream 11 of an aqueous suspension of papermaking fibers onto the forming fabric 13 which serves to support and carry the newly-formed wet web downstream in the process as the web is partially dewatered to a
30 consistency of about 10 dry weight percent. Additional dewatering of the wet web can be carried out; such as by vacuum suction, while the wet web is supported by the forming fabric.

The wet web is then transferred from the forming fabric to a transfer fabric 17 traveling at a slower speed than the forming fabric in order to impart increased stretch into
35 the web. Transfer is preferably carried out with the assistance of a vacuum shoe 18 and a

fixed gap or space between the forming fabric and the transfer fabric or a kiss transfer to avoid compression of the wet web.

The web is then transferred from the transfer fabric to the through-air drying fabric 19 with the aid of a vacuum transfer roll 20 or a vacuum transfer shoe, optionally again using a fixed gap transfer as previously described. The through-air drying fabric can be traveling at about the same speed or a different speed relative to the transfer fabric. If desired, the through-air drying fabric can be run at a slower speed to further enhance stretch. Transfer is preferably carried out with vacuum assistance to ensure deformation of the sheet to conform to the through-air drying fabric, thus yielding desired bulk and appearance.

The level of vacuum used for the web transfers can be from about 75 to about 380 millimeters of mercury, preferably about 125 millimeters of mercury. The vacuum shoe (negative pressure) can be supplemented or replaced by the use of positive pressure from the opposite side of the web to blow the web onto the next fabric in addition to or as a replacement for sucking it onto the next fabric with vacuum. Also, a vacuum roll or rolls can be used to replace the vacuum shoe(s).

While supported by the through-air drying fabric, the web is final dried to a consistency of about 94 percent or greater by the through-air dryer 21 and thereafter transferred to a carrier fabric 22. An optional pressurized turning roll 26 can be used to facilitate transfer of the web from carrier fabric 22 to fabric 25. Suitable carrier fabrics for this purpose are Albany International 84M or 94M and Asten 959 or 937, all of which are relatively smooth fabrics having a fine pattern. Although not shown, reel calendering or subsequent off-line calendering can be used to improve the smoothness and softness of the first layer of the basesheet.

In certain aspects it may be desirable to have particular combinations of non-wood and wood pulp fibers within a given layer to provide desired characteristics. For example, it may be desirable to combine non-wood and wood fibers having different average fiber lengths, coarseness, cell wall thickness, or other characteristics, in certain layers.

Just as the amount of non-wood within any given layer may be varied, the ratio of non-wood fibers to total fiber in the web may generally vary depending on the desired properties of the tissue product. For instance, the use of a thicker non-wood layer typically results in a tissue product with higher durability but lower softness. Additionally, the use of a large amount of non-wood fibers may negatively impact sheet formation and may increase the cost of manufacture. Likewise, the use of very low amounts of non-wood fibers, i.e., less than about 10 percent of the total weight of the web, typically results in a

tissue product having little discernable difference compared to tissue products manufactured without non-wood fibers. Thus, in certain aspects, tissue webs prepared according to the present disclosure include non-wood fibers in an amount from about 10 to about 80 percent by weight of the web, preferably from about 15 to about 60 percent, and more preferably from about 25 to about 50 percent. Tissue webs can include more than one type of non-wood fiber as well.

As noted previously, in a preferred aspect non-wood fibers are introduced to the web as a replacement for softwood fibers, accordingly in such preferred aspects the amount of softwood fibers in the web may range from about 0 to about 20 percent by weight of the total web, more preferably from 0 to about 10 percent and most preferably less than about 5 percent by weight of the total web. In one preferred aspect the amount of softwood fiber in the web is less than 1 percent by weight of the total web.

EXAMPLES

The following examples further describe and demonstrate aspects within the scope of the present disclosure. The examples are given solely for the purpose of illustration and are not to be construed as limitations of the present disclosure, as many variations thereof are possible. The results indicate tissue can be made including non-wood alternative fibers such as kenaf, wheat straw, miscanthus, corn stover, and bamboo. This disclosure is about tree-free tissue, which is a significant contrast to the current practice that relies on wood pulp.

The present disclosure removes or reduces the hemicellulose content of non-wood fibers to decrease tensile strength of the fibers, thus improving product softness for tissue sheets made from non-wood pulps. Table 2 demonstrates see that the tensile index for wheat straw and corn stover pulp are significantly higher than commercial hardwood eucalyptus pulp when hemicellulose is not removed. The much higher tensile strength will negatively impact tissue softness. Removing more than 50% of the hemicellulose from the corn stover and wheat straw resulted in a significant drop in tensile index. The ability to control hemicellulose composition in non-wood pulps allows for the use of non-wood based pulp derived from agriculture fibers in tissue products without sacrificing product softness.

TABLE 2

	CSF ml	Tensile Index	WRV
Eucalyptus	534	19.33	
NBSK	665	22.4	
Corn Stover	316	88.8	3.68
Corn Stover*	394	45.5	3.48
Wheat Straw	349	72	2.80
Wheat Straw*	376	47.6	2.41

*Pulp with partial hemicellulose removal

It should be noted that for most fiber applications, high tensile strength is a positive attribute. In tissue, however, higher tensile strength compromises the softness of the product. This is unique to tissue and not to other paper products. To date most work on use of non-wood fibers has been focused on the broad category of paper rather than the unique needs of tissue.

The methods described herein allow one to control the level of hemicellulose in a fiber to reach the desired tensile index/CSF profile. Fig. 2 illustrates the effect of reducing hemicellulose on tensile index and CSF, where the solid dots represent fibers with original levels of hemicellulose and the open dots represent fibers with reduced hemicellulose. Reducing the amount of hemicellulose in a fiber significantly reduces the tensile index of the fiber. This ability to adjust or dial in a tensile index/CSF profile by controlling hemicellulose level enables a biorefinery to run agriculture residuals of various types and purpose-grown biomasses with similar fiber properties throughout the year according to their seasonality and availability. The resulting fibers can have nearly identical properties regardless of fiber source.

In a first particular aspect, a tissue sheet includes softwood fibers and treated non-wood fibers from plants in the *Poaceae* family, wherein the treated non-wood fibers have less than 15 percent hemicellulose.

A second particular aspect includes the first particular aspect, wherein the non-wood fibers are selected from the group consisting of wheat, corn, miscanthus, bamboo, and combinations thereof.

A third particular aspect includes the first and/or second aspect, further comprising eucalyptus fiber.

A fourth particular aspect includes one or more of aspects 1-3, further comprising hardwood fiber.

A fifth particular aspect includes one or more of aspects 1-4, comprising two outer layers and at least one inner layer.

A sixth particular aspect includes one or more of aspects 1-5, wherein an outer layer comprises hardwood fibers and non-wood fibers and the at least one inner layer
5 comprises softwood fibers.

A seventh particular aspect includes one or more of aspects 1-6, wherein the at least one inner layer comprises hardwood fibers and non-wood fibers.

An eighth particular aspect includes one or more of aspects 1-7, wherein the two outer layers comprise hardwood fibers.

10 A ninth particular aspect includes one or more of aspects 1-8, wherein the treated non-wood fibers have at least 50 percent less hemicellulose than the same non-wood fibers without treatment.

A tenth particular aspect includes one or more of aspects 1-9, wherein the treated non-wood fibers have at least 70 percent less hemicellulose than the same non-wood
15 fibers without treatment.

An eleventh particular aspect includes one or more of aspects 1-10, wherein the tissue sheet is softer and more durable than a tissue sheet comprising softwood fiber and eucalyptus fiber in the place of the treated non-wood fiber.

A twelfth particular aspect includes one or more of aspects 1-11, wherein the
20 treated non-wood fiber has a higher CSF and a lower WRV than eucalyptus fiber.

In a thirteenth particular aspect, a tissue sheet consists essentially of softwood fibers and treated non-wood fibers, wherein the treated non-wood fibers have less than 15 percent hemicellulose.

A fourteenth particular aspect include the thirteenth particular aspects, wherein the
25 treated non-wood fibers have at least 30 percent less hemicellulose than the same non-wood fibers without treatment.

A fifteenth particular aspect includes the thirteenth and/or fourteenth particular aspects, wherein the treated non-wood fibers have at least 50 percent less hemicellulose than the same non-wood fibers without treatment.

30 In a sixteenth particular aspect, a method for customizing the tensile index and Canadian standard freeness (CSF) of fibers in a tissue sheet includes treating non-wood fibers by removing a portion of hemicellulose from the non-wood fibers; forming a tissue sheet comprising softwood fibers and the treated non-wood fibers; and adjusting the

portion of hemicellulose removed from the non-wood fibers to achieve a desired the tensile index and Canadian standard freeness (CSF) of the treated non-wood fibers.

A seventeenth particular aspect includes the sixteenth particular aspect, the tissue sheet further comprising eucalyptus fiber.

5 An eighteenth particular aspect includes the sixteenth and/or seventeenth particular aspects, the tissue sheet further comprising hardwood fiber.

A nineteenth particular aspect includes one or more of aspects 16-18, wherein the non-wood fibers are selected from plants in the *Poaceae* family including wheat, corn, miscanthus, and bamboo.

10 A twentieth particular aspect, includes one or more of aspects 16-19, wherein the treated non-wood fibers have less than 15 percent hemicellulose.

All percentages, parts and ratios are based upon the total weight of the compositions of the present disclosure, unless otherwise specified. All such weights as they pertain to listed ingredients are based on the active level and, therefore; do not
15 include solvents or by-products that can be included in commercially available materials, unless otherwise specified. The term "weight percent" can be denoted as "wt. %" herein. Except where specific examples of actual measured values are presented, numerical values referred to herein should be considered to be qualified by the word "about."

The dimensions and values disclosed herein are not to be understood as being
20 strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm."

All documents cited in the Detailed Description are, in relevant part, incorporated
25 herein by reference; the citation of any document is not to be construed as an admission that it is prior art with respect to the present disclosure. To the extent that any meaning or definition of a term in this written document conflicts with any meaning or definition of the term in a document incorporated by reference, the meaning or definition assigned to the term in this written document shall govern.

30 While particular aspects of the present disclosure have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the disclosure. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this disclosure.

What is claimed is:

1. A tissue sheet comprising:
softwood fibers; and
treated non-wood fibers from plants in the *Poaceae* family, wherein the treated
5 non-wood fibers have less than 15 percent hemicellulose.
2. The tissue sheet of claim 1, wherein the non-wood fibers are selected from
the group consisting of wheat, corn, miscanthus, bamboo, and combinations thereof.
- 10 3. The tissue sheet of claim 1, further comprising eucalyptus fiber.
4. The tissue sheet of claim 1, further comprising hardwood fiber.
5. The tissue sheet of claim 1, comprising two outer layers and at least one
15 inner layer.
6. The tissue sheet of claim 5, wherein an outer layer comprises hardwood
fibers and non-wood fibers and the at least one inner layer comprises softwood fibers.
- 20 7. The tissue sheet of claim 5, wherein the at least one inner layer comprises
hardwood fibers and non-wood fibers.
8. The tissue sheet of claim 5, wherein the two outer layers comprise
hardwood fibers.
- 25 9. The tissue sheet of claim 1, wherein the treated non-wood fibers have at
least 50 percent less hemicellulose than the same non-wood fibers without treatment.
10. The tissue sheet of claim 1, wherein the treated non-wood fibers have at
30 least 70 percent less hemicellulose than the same non-wood fibers without treatment.

11. The tissue sheet of claim 1, wherein the tissue sheet is softer and more durable than a tissue sheet comprising softwood fiber and eucalyptus fiber in the place of the treated non-wood fiber.

5

12. The tissue sheet of claim 1, wherein the treated non-wood fiber has a higher CSF and a lower WRV than eucalyptus fiber.

13. A tissue sheet consisting essentially of softwood fibers and treated non-wood fibers, wherein the treated non-wood fibers have less than 15 percent hemicellulose.

14. The tissue sheet of claim 13, wherein the treated non-wood fibers have at
5 least 30 percent less hemicellulose than the same non-wood fibers without treatment.

15. The tissue sheet of claim 13, wherein the treated non-wood fibers have at least 50 percent less hemicellulose than the same non-wood fibers without treatment.

10

16. A method for customizing the tensile index and Canadian standard freeness (CSF) of fibers in a tissue sheet, the method comprising:

treating non-wood fibers by removing a portion of hemicellulose from the non-wood fibers;

5 forming a tissue sheet comprising softwood fibers and the treated non-wood fibers;
and

adjusting the portion of hemicellulose removed from the non-wood fibers to achieve a desired the tensile index and Canadian standard freeness (CSF) of the treated non-wood fibers.

10

17. The method of claim 16, the tissue sheet further comprising eucalyptus fiber.

18. The method of claim 16, the tissue sheet further comprising hardwood fiber.

15

19. The method of claim 16, wherein the non-wood fibers are selected from plants in the *Poaceae* family including wheat, corn, miscanthus, and bamboo.

20. The method of claim 16, wherein the treated non-wood fibers have less
20 than 15 percent hemicellulose.

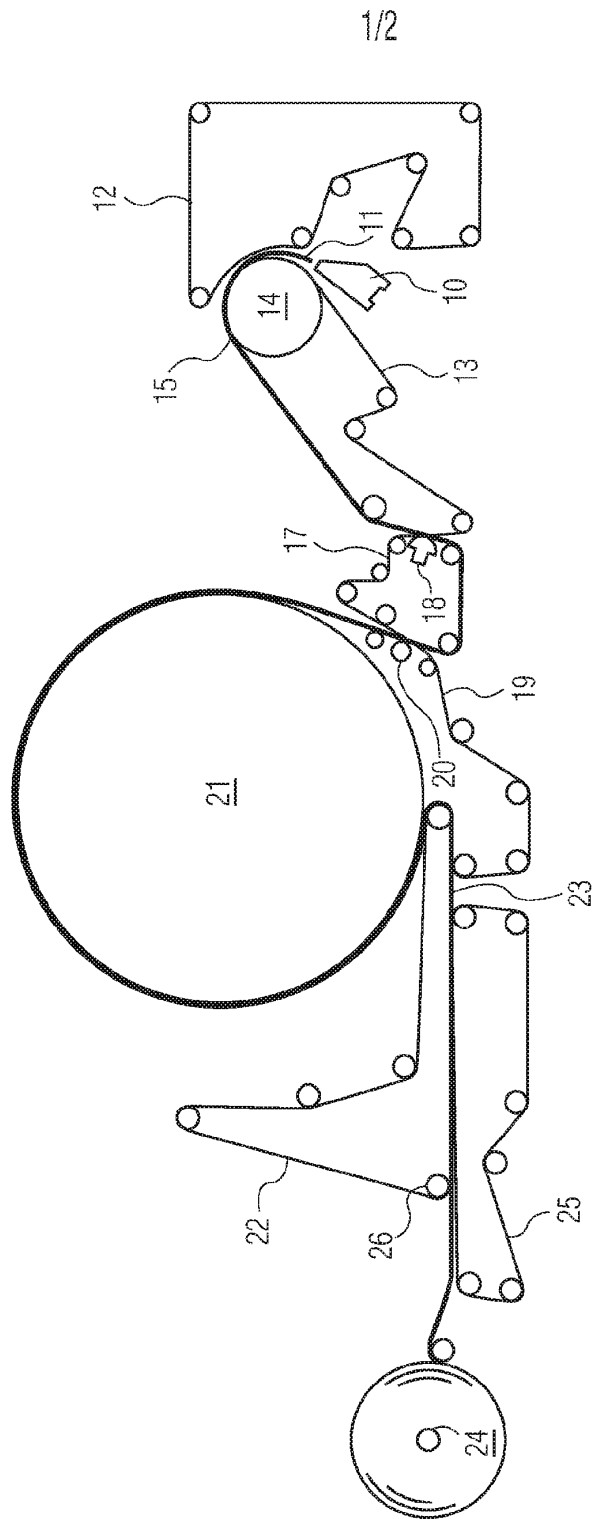


FIG. 1

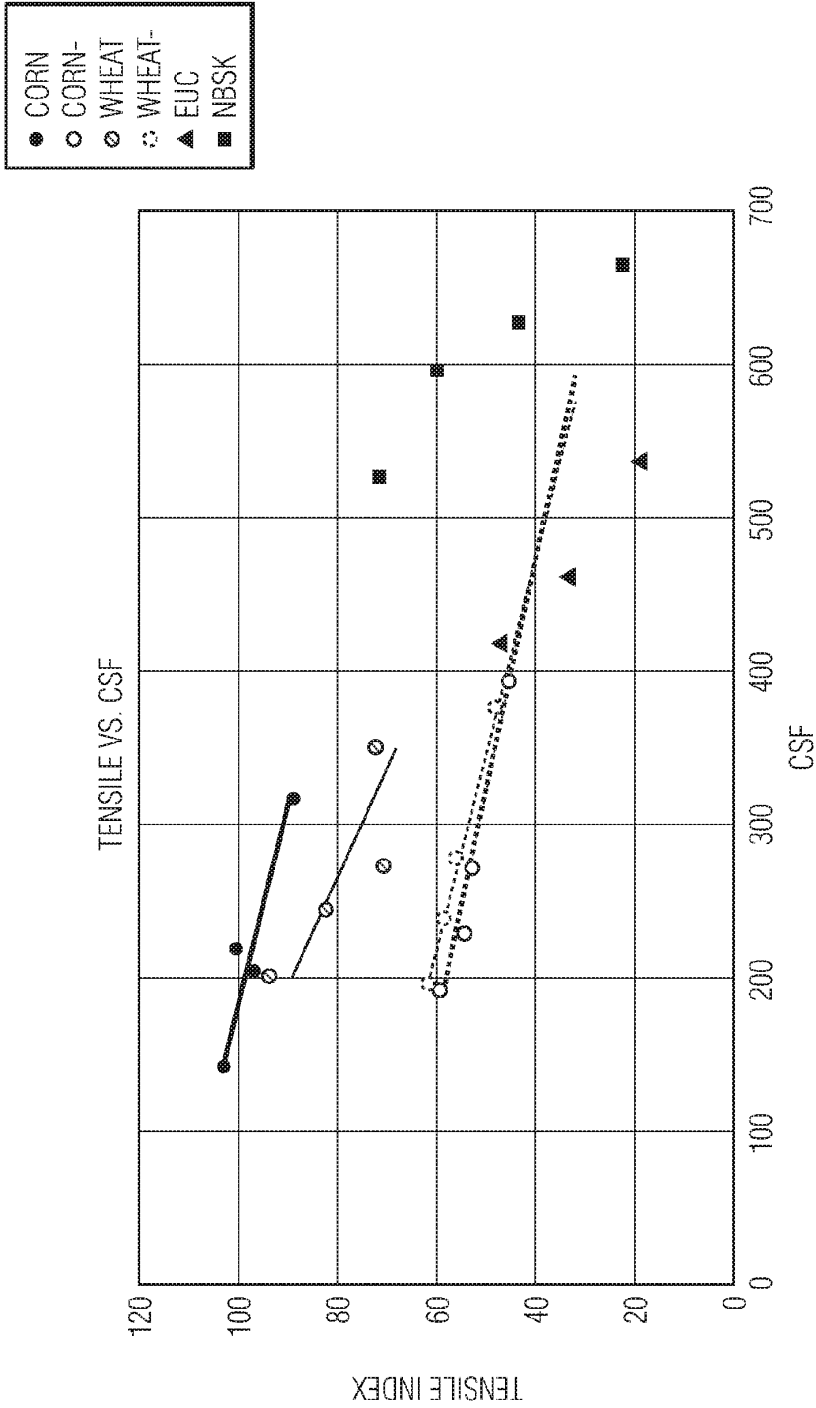


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/029112

A. CLASSIFICATION OF SUBJECT MATTER D21H 11/12(2006.01)i, D21H 11/18(2006.01)i, D21H 27/00(2006.01)i		
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) D21H 11/12; D21H 17/09; D21C 5/00; D21H 11/04; D21H 17/07; D21C 9/14; D21H 27/00; D21C 3/02; D21C 3/20; D21H 11/18		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models Japanese utility models and applications for utility models		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS(KIPO internal) & Keywords: tissue, softwood fiber, hardwood fiber, non-wood fiber, layer, hemicellulose, eucalyptus		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016-0138224 A1 (KIMBERLY-CLARK WORLDWIDE, INC.) 19 May 2016 See paragraphs [0009]; [0028]; and claims 1, 8-10, 12, 18, 20.	16-19
Y		1-15, 20
Y	WO 2016-079045 A1 (NOVOZYME A/S) 26 May 2016 See page 3, line 30; page 17, lines 5-7; and claim 1.	1-15, 20
Y	US 2014-0048223 A1 (CELANESE INTERNATIONAL CORPORATION) 20 February 2014 See paragraphs [0003], [0010], [0030]; and claims 1, 2.	1-15, 20
Y	US 2015 0184343 A1 (CELANESE INTERNATIONAL CORPORATION) 02 July 2015 See paragraphs [0003], [0010], [0027]; and claim 1.	1 15, 20
A	US 2015-0184338 A1 (EVERHAUSER NR COMPANY) 02 July 2015 See the whole document.	1-20
☐ Further documents are listed in the continuation of Box C. ☒ 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 "I" 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 24 August 2018 (24.08.2018)		Date of mailing of the international search report 24 August 2018 (24.08.2018)
Name and mailing address of the ISA/KR International Application Division Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578		Authorized officer LEE, Dong Wook Telephone No. +82-42-481-8163

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2018/029112

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016-0138224 A1	19/05/2016	AU 2013-392117 A1 CA 2914267 A1 EP 3008242 A1 KR 10-2016-0018586 A WO 2014-200456 A1	28/01/2016 18/12/2014 20/04/2016 17/02/2016 18/12/2014
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2018/029112

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015-0184338 A1	02/07/2015	CN 104746375 A CN 104746375 B CN 107740303 A	01/07/2015 17/11/2017 27/02/2018

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 18/131,383		Filing Date 04/06/2023		☐ To be Mailed			
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO											
APPLICATION AS FILED - PART I											
		(Column 1)		(Column 2)							
FOR		NUMBER FILED		NUMBER EXTRA		RATE (\$)		FEE (\$)			
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A		N/A		N/A					
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))		N/A		N/A		N/A					
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A		N/A		N/A					
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =		*		x \$100 =					
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =		*		x \$ 480 =					
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).									
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))											
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL					
APPLICATION AS AMENDED - PART II											
		(Column 1)		(Column 2)		(Column 3)					
AMENDMENT	08/14/2025	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 21	Minus	** 21	= 0			x \$ 200 =		0	
	Independent (37 CFR 1.16(h))	* 5	Minus	*** 5	= 0			x \$ 600 =		0	
	☐ Application Size Fee (37 CFR 1.16(s))										
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))										
								TOTAL ADD'L FEE		0	
		(Column 1)		(Column 2)		(Column 3)					
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	*	Minus	**	=			x \$ 0 =			
	Independent (37 CFR 1.16(h))	*	Minus	***	=			x \$ 0 =			
	☐ Application Size Fee (37 CFR 1.16(s))										
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))										
								TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.								SLIE			
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".								/ALA H HUNTER/			
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".											
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.											

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 18/131,383
Inventors : Christopher Michael YOUNG et al.
Filed : April 6, 2023
Art Unit : 1748
Examiner : JOSE A FORTUNA
Docket No. : 16255M3
Confirmation No. : 7685
Customer No. : 27752
Title : Soft Sanitary Tissue Products Comprising Non-wood Fibers

SUBMISSION OF AMENDMENT WITH FILING OF RCE

The Director is hereby authorized to charge all required fees (including any extension of time fees) and to credit any overpayments in this and any concurrent or future correspondence to Deposit Account No. 16-2480.

In response to the Final Office Action dated July 23, 2025 (the “Office Action”), in the above-identified application (the “Subject Application”), please consider the following amendments and remarks and reconsider the Subject Application.

Amendments to the Claims begin on page 2 of this paper.

Remarks begin on page 6 of this paper.

AMENDMENTS TO THE CLAIMS

This Listing of the Claims replaces all claim sets in the Subject Application.

Listing of the Claims:

1. (Currently Amended) A multi-ply sanitary tissue product, comprising:
at least about 5% to about 100% by weight non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof;
wherein the multi-ply sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of the non-wood fibers~~a consumer-facing surface comprising at least a portion of the non-wood fibers~~; and
wherein the multi-ply sanitary tissue product exhibits a TS7 of less than about 14 dB V² rms.
2. (Previously Presented) The multi-ply sanitary tissue product of claim 1, wherein the non-wood fibers consist of bamboo fibers.
3. (Previously Presented) The multi-ply sanitary tissue product of claim 1, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.
4. (Previously Presented) The multi-ply sanitary tissue product of claim 1, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the non-wood fibers.
5. (Currently Amended) A multi-ply sanitary tissue product, comprising:
at least about 5% to about 100% by weight bamboo fibers;
wherein the multi-ply sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of the bamboo fibers~~a consumer-facing surface comprising at least a portion of the bamboo fibers~~; and

wherein the multi-ply sanitary tissue product exhibits a TS750 less than about 45 dB V² rms.

6. (Previously Presented) The multi-ply sanitary tissue product of claim 5, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.

7. (Previously Presented) The multi-ply sanitary tissue product of claim 5, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the bamboo fibers.

8. (Previously Presented) The multi-ply sanitary tissue product of claim 5, wherein the multi-ply sanitary tissue product comprises greater than about 75% to about 100% by weight of the bamboo fibers.

9. (Currently Amended) A multi-ply ~~structured~~ sanitary tissue product, comprising:
at least about 5% to about 100% by weight non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof;

wherein the multi-ply sanitary tissue product comprises wherein the multi-ply sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of non-wood fibers~~a consumer-facing surface comprising at least a portion of the non-wood fibers~~; and

wherein the multi-ply sanitary tissue product exhibits a TS750 less than about 45 dB V² rms.

10. (Previously Presented) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product comprises a structured fibrous structure.

11. (Previously Presented) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.

12. (Previously Presented) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the non-wood fibers.

13. (Previously Presented) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product exhibits a TS750 of less than 40 dB V² rms.

14. (Previously Presented) The multi-ply sanitary tissue product of claim 9, wherein the multi-ply sanitary tissue product exhibits a TS750 of from about 25 to about 35 dB V² rms.

15. (Withdrawn) A sanitary tissue product, comprising:
non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof; and
a slip stick less than about 435.

16. (Withdrawn) The sanitary tissue product of claim 15, wherein the non-wood fibers consist of bamboo fibers.

17. (Withdrawn) The sanitary tissue product of claim 15, wherein the slip stick is from about 235 to about 435.

18. (Withdrawn) A structured sanitary tissue product, comprising:
non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof; and
a slip stick less than about 605.

19. (Withdrawn) The sanitary tissue product of claim 18, wherein the slip stick is from about 235 to about 605.

20. (Withdrawn) The sanitary tissue product of claim 18, wherein the slip stick is from about 350 to about 500.

Appl. No. 18/131,383 5
Docket No. 16255M3
Reply to Office Action mailed on July 23, 2025
Customer No. 27752

21. (Withdrawn) The sanitary tissue product of claim 18, wherein the sanitary tissue product comprises a through-air-dried (TAD) and uncreped web.

REMARKS

Claim Status

Claims 1-21 are pending in the present application. Claims 15-21 have been withdrawn as a result of an earlier restriction requirement. Claims 1, 5, and 9 have been amended to define the claimed invention with greater specificity by reciting a multi-ply sanitary tissue product comprising at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of non-wood fibers. Support for these amendments is found throughout the Specification, Claims, and/or Drawings as originally filed.

Rejection Under 35 USC §103 over Kleinwaechter in view of Rouse

Claims 1-14 are rejected under 35 U.S.C. 103 as allegedly being unpatentable over US Patent Application Publication No. 2019/0366676 to Kleinwaechter et al. (hereafter “Kleinwaechter”) in view of WO 2018/156109 to Rouse et al. (hereafter “Rouse”).

Applicant respectfully submits that Kleinwaechter in view of Rouse fails to teach each and every element of Claims 1, 5, and 9, the independent claims, as amended, because Kleinwaechter in view of Rouse, fails to teach, at a minimum, a multi-ply sanitary tissue product comprising at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers comprise at least about 5% by weight of the layer of the non-wood fibers. Accordingly, Applicant respectfully submits that Claims 1, 5, and 9, as amended, are not rendered obvious over Kleinwaechter in view of Rouse. MPEP 2143.03. Further, Applicant respectfully submits that Claims 2-4, 6-8, and 10-14, which ultimately depend from Claims 1, 5, and 9, as amended, respectively, are not rendered obvious over Kleinwaechter in view of Rouse. MPEP 2143.03.

Conclusion

This response represents an earnest effort to place the present application in proper form and to distinguish the invention as claimed from the applied reference(s). In view of the foregoing, entry of the amendment(s) presented herein, reconsideration of this application, and allowance of the pending claim(s) are respectfully requested.

7

By James E. Oehlenschlager /JEO/
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James E. Oehlenschlaeger
Registration No. 50164
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Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	18/131,383
Filing Date	04/06/2023
First Named Inventor	Christopher Michael YOUNG
Art Unit	1748
Examiner Name	JOSE A FORTUNA
Attorney Docket Number	16255M3

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. **Submission required under 37 CFR 1.114** Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

- a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
- i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ii. ☐ Other _____
- b. ☒ Enclosed
- i. ☒ Amendment/Reply
- iii. ☐ Information Disclosure Statement (IDS)
- ii. ☐ Affidavit(s)/ Declaration(s)
- iv. ☐ Other _____

2. Miscellaneous

- a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)
- b. ☐ Other _____

3. Fees

- The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.
- The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 16-2480.
- i. ☒ RCE fee required under 37 CFR 1.17(e)
- ii. ☐ Extension of time fee (37 CFR 1.136 and 1.17)
- iii. ☐ Other _____
- b. ☐ Check in the amount of \$ _____ enclosed
- c. ☐ Payment by credit card (Form PTO-2038 enclosed)
- d. ☒ Payment by USPTO patent electronic filing system.

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SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	<i>JEO</i>	Date	August 14, 2025
Name (Print/Type)	James E. Oehlenschlaeger	Registration No.	50164

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is transmitted by the USPTO patent electronic filing system, or by facsimile to (571) 273-8300, to the USPTO, or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450, on the date shown below.

Signature	/Bonnie S. Combs/	Date	August 14, 2025
Name (Print/Type)	Bonnie S. Combs		

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Instruction Sheet for RCEs

(not to be submitted to the USPTO)

NOTES:

An RCE is not a new application, and filing an RCE will not result in an application being accorded a new filing date.

Filing Qualifications:

The application must be a utility or plant application filed on or after June 8, 1995. The application cannot be a provisional application, a utility or plant application filed before June 8, 1995, a design application, or a patent under reexamination. See 37 CFR 1.114(e).

Filing Requirements:

Prosecution in the application must be closed. Prosecution is closed if the application is under appeal, or the last Office action is a final action, a notice of allowance, or an action that otherwise closes prosecution in the application (e.g., an Office action under *Ex parte Quayle*). See 37 CFR 1.114(b).

A submission and a fee are required at the time the RCE is filed. If reply to an Office action under 35 U.S.C. 132 is outstanding (e.g., the application is under final rejection), the submission must meet the reply requirements of 37 CFR 1.111. If there is no outstanding Office action, the submission can be an information disclosure statement, an amendment, new arguments, or new evidence. See 37 CFR 1.114(c). The submission may be a previously filed amendment (e.g., an amendment after final rejection).

WARNINGS:

Request for Suspension of Action:

All RCE filing requirements must be met before suspension of action is granted. A request for a suspension of action under 37 CFR 1.103(c) does not satisfy the submission requirement and does not permit the filing of the required submission to be suspended.

Improper RCE will NOT toll Any Time Period:

Before Appeal - If the RCE is improper (e.g., prosecution in the application is not closed or the submission or fee has not been filed) and the application is not under appeal, the time period set forth in the last Office action will continue to run and the application will be abandoned after the statutory time period has expired if a reply to the Office action is not timely filed. No additional time will be given to correct the improper RCE.

Under Appeal - If the RCE is improper (e.g., the submission or the fee has not been filed) and the application is under appeal, the improper RCE is effective to withdraw the appeal. Withdrawal of the appeal results in the allowance or abandonment of the application depending on the status of the claims. If there are no allowed claims, the application is abandoned. If there is at least one allowed claim, the application will be passed to issue on the allowed claim(s). See MPEP 1215.01.

See MPEP 706.07(h) for further information on the RCE practice.

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
08/14/2025 02:27:31 PM Z ET

ATTORNEY DOCKET #
16255M3

Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 7685

FILED BY Bonnie Combs

PATENT CENTER # 71858336

AUTHORIZED BY James Oehlenschlager

CUSTOMER # 27752

FILING DATE 04/06/2023

CORRESPONDENCE ADDRESS -

FIRST NAMED INVENTOR Christopher Michael YOUNG

Payment Information

PAYMENT METHOD
DA / 162480

PAYMENT TRANSACTION ID
E20258DE28249577

PAYMENT AUTHORIZED BY
Bonnie Combs

PRE-AUTHORIZED ACCOUNT
162480

PRE-AUTHORIZED CATEGORY

37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)

FEE CODE	DESCRIPTION	ITEM PRICE(\$)	QUANTITY	ITEM TOTAL(\$)
1801	REQUEST FOR CONTINUED EXAMINATION (RCE) - 1ST REQUEST (SEE 37 CFR 1.114)	1500.00	1	1500.00
TOTAL AMOUNT:				\$1,500.00

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New Applications Under 35 U.S.C. 111

Kimberly Clark EX1002, p. 4636
PGR2026-00078

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
08/14/2025 02:27:31 PM Z ET

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Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

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FILING DATE 04/06/2023

CUSTOMER # 27752

FIRST NAMED Christopher Michael YOUNG
INVENTOR

CORRESPONDENCE -
ADDRESS

AUTHORIZED BY James Oehlenschlager

Documents

TOTAL DOCUMENTS: 4

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
16255M3-Amend-filed-08-14-25.pdf		7	-	107 KB
16255M3-Amend-filed-08-14-25-AMSB.pdf	(1-1)	1	Amendment Submitted/Entered with Filing of Continued Prosecution Application (CPA)/Request for Continued Examination(RCE)	95 KB
16255M3-Amend-filed-08-14-25-CLM.pdf	(2-5)	4	Claims	80 KB
16255M3-Amend-filed-08-14-25-REM.pdf	(6-7)	2	Applicant Arguments/Remarks Made in an Amendment	51 KB
16255M3-RCE-filed-08-14-25.pdf		3	Request for Continued Examination (RCE)	382 KB

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16255M3-Amend-filed-08-14-25-AMSB.pdf	FC9D1A7D70400ED3B88A4149B6F313798F2D118C2C50266DD B65FB63EF9DFF3039600F000A5F88E7D9B3F81DEA78205938 A523C3D956CECCC01EEB8F45DBF2E8
16255M3-Amend-filed-08-14-25-CLM.pdf	B8F9D80F3C8B5EE9B172B5B5C1533CDACA7899170BFF7936 87E8D23817BED11C637CF3CCF517C100B0DEB48655C815C8 6BA7B8AF288E261FDB8A6CB6D21E25FC
16255M3-Amend-filed-08-14-25-REM.pdf	BAF1FDB597EEC23D2064D29403F4CD744B73E92D4199C1D7 56360BAE1946BC2A2F3F4C57D2E1574CBFDB0542B1DB0C95 6BE1457994FBF3E9705D7C0113595938
16255M3-RCE-filed-08-14-25.pdf	89A951D8B5607D065992C5E4D57B1C90484FFAC39855E1DF6 4FB397B760461FD9EB6EFDDEABFA4AB38C6FD298F79F3A3E A438927DCF514D13BDF09C4478FC72F

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

27752 7590 09/02/2025
THE PROCTER & GAMBLE COMPANY
GLOBAL IP SERVICES
CENTRAL BUILDING, C9
ONE PROCTER AND GAMBLE PLAZA
CINCINNATI, OH 45202

EXAMINER

FORTUNA, JOSE A

ART UNIT

PAPER NUMBER

1748

DATE MAILED: 09/02/2025

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/131,383	04/06/2023	Christopher Michael YOUNG	16255M3	7685

TITLE OF INVENTION: Soft Sanitary Tissue Products Comprising Non-wood Fibers

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1290	\$0.00	\$0.00	\$1290	12/02/2025

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via the USPTO patent electronic filing system.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

27752 7590 09/02/2025
THE PROCTER & GAMBLE COMPANY
GLOBAL IP SERVICES
CENTRAL BUILDING, C9
ONE PROCTER AND GAMBLE PLAZA
CINCINNATI, OH 45202

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/131,383	04/06/2023	Christopher Michael YOUNG	16255M3	7685

TITLE OF INVENTION: Soft Sanitary Tissue Products Comprising Non-wood Fibers

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1290	\$0.00	\$0.00	\$1290	12/02/2025

EXAMINER	ART UNIT	CLASS-SUBCLASS
FORTUNA, JOSE A	1748	162-148000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government4a. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required)

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☐ Electronic Payment via the USPTO patent electronic filing system ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29☐ Applicant asserting small entity status. See 37 CFR 1.27☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____

Date _____

Typed or printed name _____

Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/131,383	04/06/2023	Christopher Michael YOUNG	16255M3	7685
27752 7590 09/02/2025 THE PROCTER & GAMBLE COMPANY GLOBAL IP SERVICES CENTRAL BUILDING, C9 ONE PROCTER AND GAMBLE PLAZA CINCINNATI, OH 45202			EXAMINER FORTUNA, JOSE A	
			ART UNIT	PAPER NUMBER
			1748	

DATE MAILED: 09/02/2025

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013).

<https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf>

Routine uses of the information in this record may include disclosure to:

- 1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;
- 2) a federal, state, local, or international agency, in response to its request;
- 3) a contractor of the USPTO having need for the information in order to perform a contract;
- 4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;
- 5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;
- 6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;
- 7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;
- 8) another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c));
- 9) the Office of Personnel Management (OPM) for personnel research purposes; and
- 10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

Notice of Allowability	Application No. 18/131,383	Applicant(s) YOUNG et al.	
	Examiner JOSE A FORTUNA	Art Unit 1748	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to amendment and RCE filed on 8/14/2025.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1-14 and 22-35 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some* c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. _____ .

3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)	5. ☒ Examiner's Amendment/Comment
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.	6. ☒ Examiner's Statement of Reasons for Allowance
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.	7. ☐ Other _____.
4. ☒ Interview Summary (PTO-413), Paper No./Mail Date. _____.	

/JOSE A FORTUNA/ Primary Examiner, Art Unit 1748	
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Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Brant Cook on August 21, 2025.

The application has been amended as follows:

1. (Currently Amended) A two-ply ~~multi-ply~~ sanitary tissue product, comprising:
at least about 5% to about 100% by weight non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof;
wherein the two-ply ~~multi-ply~~ sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the at least one multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of the non-wood fibers; and

wherein the two-ply ~~multi-ply~~ sanitary tissue product exhibits a TS7 of less than about 14 dB V2 rms.
2. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 1, wherein the non-wood fibers consist of bamboo fibers.
3. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 1, wherein the two-ply ~~multi-ply~~ sanitary tissue product is a two-ply ~~multi-ply~~ toilet tissue.
4. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 1, wherein the two-ply ~~multi-ply~~ sanitary tissue product comprises greater than about 30% to about 100% by weight of the non-wood fibers.
5. (Currently Amended) A two-ply ~~multi-ply~~ sanitary tissue product, comprising:
at least about 5% to about 100% by weight bamboo fibers;

wherein the two-ply ~~multi-ply~~ sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the at least one multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of the bamboo fibers; and

wherein the two-ply ~~multi-ply~~ sanitary tissue product exhibits a TS750 less than about 45 dB V2 rms.

6. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 5, wherein the two-ply ~~multi-ply~~ sanitary tissue product is a two-ply multi-ply toilet tissue.

7. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 5, wherein the two-ply ~~multi-ply~~ sanitary tissue product comprises greater than about 30% to about 100% by weight of the bamboo fibers.

8. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 5, wherein the two-ply ~~multi-ply~~ sanitary tissue product comprises greater than about 75% to about 100% by weight of the bamboo fibers.

9. (Currently Amended) A two-ply ~~multi-ply~~ sanitary tissue product, comprising:
at least about 5% to about 100% by weight non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof;
wherein the two-ply ~~multi-ply~~ sanitary tissue product comprises wherein the two-ply ~~multi-~~

~~ply~~ sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the at least one multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of non-wood fibers; and

wherein the two-ply ~~multi-ply~~ sanitary tissue product exhibits a TS750 less than about 45 dB V2 rms.

10. (Currently Amended) The two-ply multi-ply sanitary tissue product of claim 9, wherein the two-ply ~~multi-ply~~ sanitary tissue product comprises a structured fibrous structure.

11. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 9, wherein the two-ply ~~multi-ply~~ sanitary tissue product is a two-ply multi-ply toilet tissue.

12. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 9, wherein the two-ply ~~multi-ply~~ sanitary tissue product comprises greater than about 30% to about 100% by weight of the non-wood fibers.

13. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 9, wherein the two-ply ~~multi-ply~~ sanitary tissue product exhibits a TS750 of less than 40 dB V2 rms.

14. (Currently Amended) The two-ply ~~multi-ply~~ sanitary tissue product of claim 9, wherein the two-ply ~~multi-ply~~ sanitary tissue product exhibits a TS750 of from about 25 to about 35 dB V2 rms.

15-21. (Cancelled).

22. (New) A multi-ply sanitary tissue product, comprising:
at least about 5% to about 100% by weight non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof;
wherein the multi-ply sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the at least one multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of the non-wood fibers and wherein the at least one multi-layered fibrous structure ply forms an exterior ply of the multi-ply sanitary tissue product; and
wherein the multi-ply sanitary tissue product exhibits a TS7 of less than about 14 dB V2 rms.

23. (New) The multi-ply sanitary tissue product of claim 22, wherein the non-wood fibers consist of bamboo fibers.

24. (New) The multi-ply sanitary tissue product of claim 22, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.

25. (New) The multi-ply sanitary tissue product of claim 22, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the non-wood fibers.

26. (New) A multi-ply sanitary tissue product, comprising:

at least about 5% to about 100% by weight bamboo fibers;
wherein the multi-ply sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of layers, wherein all of the layers of the at least one multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of the bamboo fibers and wherein the at least one multi-layered fibrous structure ply forms an exterior ply of the multi-ply sanitary tissue product; and
wherein the multi-ply sanitary tissue product exhibits a TS750 less than about 45 dB V2 rms.

27. (New) The multi-ply sanitary tissue product of claim 26, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.

28. (New) The multi-ply sanitary tissue product of claim 26, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the bamboo fibers.

29. (New) The multi-ply sanitary tissue product of claim 26, wherein the multi-ply sanitary tissue product comprises greater than about 75% to about 100% by weight of the bamboo fibers.

30. (New) A multi-ply sanitary tissue product, comprising:
at least about 5% to about 100% by weight non-wood fibers selected from the group consisting of bamboo, abaca, and mixtures thereof;
wherein the multi-ply sanitary tissue product comprises wherein the multi-ply sanitary tissue product comprises at least one multi-layered fibrous structure ply comprising a plurality of

layers, wherein all of the layers of the at least one multi-layered fibrous structure ply comprise at least about 5% by weight of the layer of non-wood fibers and wherein the at least one multi-layered fibrous structure ply forms an exterior ply of the multi-ply sanitary tissue product; and wherein the multi-ply sanitary tissue product exhibits a TS750 less than about 45 dB V2 rms.

31. (New) The multi-ply sanitary tissue product of claim 30, wherein the multi-ply sanitary tissue product comprises a structured fibrous structure.

32. (New) The multi-ply sanitary tissue product of claim 30, wherein the multi-ply sanitary tissue product is a multi-ply toilet tissue.

33. (New) The multi-ply sanitary tissue product of claim 30, wherein the multi-ply sanitary tissue product comprises greater than about 30% to about 100% by weight of the non-wood fibers.

34. (New) The multi-ply sanitary tissue product of claim 30, wherein the multi-ply sanitary tissue product exhibits a TS750 of less than 40 dB V2 rms.

35. (New) The multi-ply sanitary tissue product of claim 30, wherein the multi-ply sanitary tissue product exhibits a TS750 of from about 25 to about 35 dB V2 rms.

Reasons for Allowance

The following is an examiner's statement of reasons for allowance: the prior art does not teach nor fairly suggest a two/multi-ply tissue including at least one multi-layer ply in the exterior of the tissue, said ply comprising non-wood fibers in all the layers and having the claimed properties. Note that the closest reference(s), e.g., Shannon, US Patent Application Publication No. 2013/0071678 A1, teaches away from using the non-wood fibers in the external/outer surface of the web and Rouse et al., (hereinafter Rouse), WO 2018/156109 A1, teaches away from the use of non-wood fibers in the middle layer of multi-layer web/ply.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSE A FORTUNA whose telephone number is (571)272-1188. The examiner can normally be reached MONDAY- FRIDAY 11:30 PM- 9:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Abbas Rashid can be reached at 571-270-7457. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: <https://patentcenter.uspto.gov>. Visit <https://www.uspto.gov/patents/apply/patent-center> for more information about Patent Center and <https://www.uspto.gov/patents/docx> for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JOSE A FORTUNA/
Primary Examiner, Art Unit 1748

JAF

<i>Examiner-Initiated Interview Summary</i>	Application No. 18/131,383	Applicant(s) YOUNG et al.		
	Examiner JOSE A FORTUNA	Art Unit 1748	AIA (First Inventor to File) Status Yes	Page 1 of 1

All Participants (applicant, applicants representative, PTO personnel)	Title	Type
JOSE A FORTUNA	Primary Examiner	Telephonic
C. Brant Cook	Attorney of Record	

Date of Interview: 20 August 2025

Issues Discussed:

Proposed Amendment(s)

The examiner called applicants' attorney to propose and amendment in order to put the application in condition for allowance. The examiner propose to include a limitation implicitly and/or explicitly stating that a multi-layer web of a multi-ply tissue were part of the outer surface of the product, i.e., the tissue, so to overcome a possible obvious rejection over Shannon, US Patent Application Publication No. 2013/0071678 A1. Attorney Cook presented a draft and the examiner agreed to added as an examiner's amendment.

/JOSE A FORTUNA/ Primary Examiner, Art Unit 1748	
<p>Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04</p> <p>Please further see: MPEP 713.04 Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b) 37 CFR § 1.2 Business to be transacted in writing</p>	

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

<i>Notice of References Cited</i>	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.	
	Examiner JOSE A FORTUNA	Art Unit 1748	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
	A					
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N	WO-2025165801-A1	2025-08-07	WO	YOUNG, CHRISTOPHER, MICHAEL	
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title, Date, Publisher, Edition or Volume, Pertinent Pages
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 11-2023)

Notice of References Cited

Part of Paper No. 20250821

Issue Classification 	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.
	Examiner JOSE A FORTUNA	Art Unit 1748

CPC						
Symbol					Type	Version
D21H	/	27	/	005	F	2013-01-01
D21H	/	11	/	12	I	2013-01-01
A47K	/	10	/	16	I	2013-01-01
D21H	/	27	/	004	I	2013-01-01
D21H	/	27	/	30	I	2013-01-01
D21H	/	27	/	002	I	2013-01-01
D21H	/	27	/	02	I	2013-01-01
D21H	/	27	/	40	I	2013-01-01
D21H	/	17	/	26	I	2013-01-01
D21H	/	21	/	10	I	2013-01-01
D21H	/	21	/	20	I	2013-01-01

CPC Combination Sets					
Symbol			Type	Set	Ranking
	/				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	28	
/JOSE A FORTUNA/ Primary Examiner, Art Unit 1748	21 August 2025	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1, 5 & 9	1A

Issue Classification 	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.
	Examiner JOSE A FORTUNA	Art Unit 1748

INTERNATIONAL CLASSIFICATION			
CLAIMED			
D21H27/00	/	27	/ 00
D21H11/12	/	11	/ 12
D21H27/30	/	27	/ 30
D21H27/02	/	27	/ 02
D21H27/40	/	27	/ 40
NON-CLAIMED			
A47K10/16	/	10	/ 16
D21H17/26	/	17	/ 26
D21H21/10	/	21	/ 10
D21H21/20	/	21	/ 20

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	28	
/JOSE A FORTUNA/ Primary Examiner, Art Unit 1748 (Primary Examiner)	21 August 2025 (Date)	O.G. Print Claim(s) 1, 5 & 9	O.G. Print Figure 1A

U.S. Patent and Trademark Office

Part of Paper No.: 20250821

Issue Classification 	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.
	Examiner JOSE A FORTUNA	Art Unit 1748

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	10	10	-	19	21	28								
2	2	11	11	-	20	22	29								
3	3	12	12	-	21	23	30								
4	4	13	13	15	22	24	31								
5	5	14	14	16	23	25	32								
6	6	-	15	17	24	26	33								
7	7	-	16	18	25	27	34								
8	8	-	17	19	26	28	35								
9	9	-	18	20	27										

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 28	
/JOSE A FORTUNA/ Primary Examiner, Art Unit 1748 (Primary Examiner) _____ (Date) _____		O.G. Print Claim(s) 1, 5 & 9	O.G. Print Figure 1A

<i>Search Notes</i> 	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.
	Examiner JOSE A FORTUNA	Art Unit 1748

CPC - Searched*		
Symbol	Date	Examiner
D21H 27/005, 11/12, 17/26, 21/10, 21/20, 27/002, 27/004, 27/02, 27/30, 27/40, 27/38	08/21/2025	JAF
A47K 10/16	08/21/2025	JAF

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Pe2e Search (All Databases)	08/21/2025	JAF
Inventor Search	08/21/2025	JAF
EPO/JPO Search	08/21/2025	JAF
Global Dossier Search	08/21/2025	JAF
Reviewed Related applications: 18,131,(381, 382, 392, 384 and 387)	08/21/2025	JAF
Similarity Search	08/21/2025	JAF
Interference Search	08/21/2025	JAF

/JOSE A FORTUNA/ Primary Examiner, Art Unit 1748	
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<i>Search Notes</i> 	Application/Control No. 18/131,383	Applicant(s)/Patent Under Reexamination YOUNG et al.
	Examiner JOSE A FORTUNA	Art Unit 1748

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
D21H	All Above	08/21/2025	JAF
A47K	All Above	08/21/2025	JAF

/JOSE A FORTUNA/ Primary Examiner, Art Unit 1748	
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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L44	1256	((("YOUNG") near3 ("Christopher")) OR ((("SHEEHAN") near3 ("Jeffrey")) OR ((("KIEN") near3 ("Kathryn")) OR ((("OSTENDORF") near3 ("Ward")))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2025/08/20 06:33 PM
L45	81668	(D21H27/005 or A47K10/16 or D21H11/12 or D21H17/26 or D21H21/10 or D21H21/20 or D21H27/002 or D21H27/004 or D21H27/02 or D21H27/30 or D21H27/40 or D21H27/38).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 06:33 PM
L46	35	(tissue towel wipe non\$wove non ADJ woven sheet web) WITH (bamboo abaca) AND (TS7 TS750)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 06:33 PM
L47	145	("10227729" OR "10731301" OR "10954417" OR "11097881" OR "11124357" OR "20080110783" OR "20080202954" OR "20090056891" OR "20090194435" OR "20090311660" OR "20090311661" OR	(US-PGPUB; USPAT)	OR	ON	ON	2025/08/20 06:33 PM

		"20160038353" OR "20160051422" OR "20180230344" OR "20210087748" OR "20210285156" OR "20220356648" OR "6926149" OR "7172073" OR "8197455" OR "8961739" OR "9242775" OR "9327888" OR "10132036" OR "10145069" OR "10337149" OR "10428465" OR "10550522" OR "20020096287" OR "20020134520" OR "20020148574" OR "20020148584" OR "20030111197" OR "20030121629" OR "20030192662" OR "20030196772" OR "20040084165" OR "20040140076" OR "20040168780" OR "20040194901" OR "20040226673" OR "20050236122" OR "20050238682" OR "20060288639" OR "20070011762" OR "20070051484" OR "20070107863" OR "20070298995" OR "20080008853" OR "20080202968" OR "20090068633" OR "20090266500" OR "20090297781" OR "20100032113" OR "20100043989" OR "20100126685" OR "20110017631" OR "20110168342" OR "20110297343" OR "20110303375" OR "20120018964" OR "20120247696" OR "20130068867" OR "20130068868" OR "20130071655" OR "20130071678" OR "20130199741" OR "20130269892" OR "20130299107" OR				
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		"20130312924" OR "20140044883" OR "20140093704" OR "20140093705" OR "20140205777" OR "20140284010" OR "20150129143" OR "20150144280" OR "20160130762" OR "20160138224" OR "20160145809" OR "20160304818" OR "20160355987" OR "20170254025" OR "20180030654" OR "20180044859" OR "20180135248" OR "20180135249" OR "20180142419" OR "20180142420" OR "20180142421" OR "20190100878" OR "20190100883" OR "20190169798" OR "20190249367" OR "20190264395" OR "20190276985" OR "20200040529" OR "20200102705" OR "20200115853" OR "20200129013" OR "20200131707" OR "20200232166" OR "20210237964" OR "20210332531" OR "20220010495" OR "20230320539" OR "20230320540" OR "20230320541" OR "20230323598" OR "20230323605" OR "3004884" OR "3994771" OR "4300981" OR "4464224" OR "4857145" OR "5320710" OR "5348620" OR "5472569" OR "5607551" OR "5656132" OR "5932068" OR "6171442" OR "6174412" OR "6248211" OR "6258207" OR "6302997" OR "6455129" OR				
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L48	165	"6511579" OR "6709550" OR "6796114" OR "6797114" OR "6821387" OR "6931313" OR "7156954" OR "7166190" OR "7682488" OR "8049060" OR "8524374" OR "8574400" OR "8741104" OR "8742181" OR "8778505" OR "9222224" OR "9410291" OR "9447545").pn. ((tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 TS750))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 06:33 PM
L49	100	5 AND @PD<"2022"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 06:33 PM
L50	73	6 AND 2	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,	OR	ON	ON	2025/08/20 06:33 PM

			IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L51	39	6 AND 2	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/08/20 06:33 PM
L52	5	("4793898" "4594130" "3585104" "5595628").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/08/20 06:33 PM
L53	6	(WO-2017019421-\$ WO-2014053947-\$).DID.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 06:33 PM
L54	137	((tissue towel wipe non\$wove non ADJ woven sheet web) WITH (bamboo abaca) AND (shannon.in.))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 06:33 PM
L55	36	((tissue towel wipe non\$wove non ADJ woven sheet web) WITH (bamboo abaca) AND (shannon.in.))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/08/20 06:33 PM
L56	15	(toilet bath) near2 tissue WITH TS750	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/08/20 06:33 PM
L57	19	(toilet bath) near2 tissue SAME TS750	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/08/20 06:33 PM

L58	44	15 NOT 14	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 06:33 PM
L59	4	15 NOT 14	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/08/20 06:33 PM
L60	260	(toilet bath) near2 tissue AND TS750	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/08/20 06:33 PM
L61	275	18 AND @pd<"2022"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 06:33 PM
L62	99	18 AND @pd<"2022"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2025/08/20 06:33 PM
L63	50	(Artificial Intelligence) Similar to: 18/131,383 with 0 CPC Selections and 0 Text Selections Text: (US-20230323605-A1 OR US-20230323604- A1 OR US- 20240110336-A1 OR WO-2023196450-A1 OR US-20230323598- A1 OR US- 20230320540-A1 OR WO-2023196451-A1 OR US-20230320539- A1 OR WO- 2023196449-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2025/08/20 06:33 PM

L64	50	<p>US-20230320541-A1 OR DE-112023001845-T5 OR CA-3005763-A1 OR WO-2018081190-A1 OR US-11162224-B2 OR US-20220064866-A1 OR DE-112023001829-T5 OR US-20230406610-A1 OR US-20230406608-A1 OR US-20230406609-A1 OR US-20230404332-A1 OR US-20220178076-A1 OR US-11198972-B2 OR EP-3526400-B1 OR US-20240229357-A1 OR US-11292229-B2 OR EP-3526401-B1 OR US-20190136459-A1 OR WO-2015095435-A1 OR US-10745865-B2 OR US-11338544-B2 OR US-20230027102-A1 OR CA-3037589-A1 OR WO-2018081192-A1 OR US-20050247416-A1 OR US-20050258576-A1 OR US-20160230347-A1 OR DE-112023002675-T5 OR US-11486097-B2 OR US-9631323-B2 OR EP-3526399-B1 OR DE-112023001835-T5 OR US-20180105992-A1 OR CA-3036890-C OR CA-3037574-C OR US-20230256705-A1 OR EP-3526404-B1 OR WO-2023245027-A1 OR EP-3526405-B1 OR US-12128665-B2 OR CA-3037098-A1).did.</p> <p>(Artificial Intelligence) Similar to: 18/131,383 with 10 CPC Selections and 2 Text Selections</p> <p>Text: (US-20230323604-A1 OR WO-2023196449-A1 OR WO-2023196451-A1 OR WO-2023196450-A1</p>	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE,	OR	ON	ON	2025/08/20 06:33 PM
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		11053643-\$ WO-2018156109-\$).DID.	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L66	1	("20190366676").pn.	(US-PGPUB)	OR	ON	ON	2025/08/20 06:33 PM
L67	31	((Multi\$1ply multi ADJ ply) AND (multi\$1layer AND Multi ADJ layer) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 TS750))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 07:46 PM
L68	0	((Multi\$1ply multi ADJ ply) AND (multi\$1layer AND Multi ADJ layer) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 TS750)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 07:46 PM
L69	0	((Multi\$1ply multi ADJ ply) AND (multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 TS750)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2025/08/20 07:46 PM

L70	89	((Multi\$1ply multi ADJ ply) AND (multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 TS750))	PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 07:47 PM
L71	0	((Multi\$1ply multi ADJ ply) AND (multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 TS750)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 10:54 PM
L72	68	((Multi\$1ply multi ADJ ply) AND (multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 AND TS750))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/20 10:55 PM
L73	0	((Multi\$1ply multi ADJ ply) AND	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2025/08/20 10:55 PM

		(multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 AND TS750)).clm.	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L74	69	((Multi\$1ply multi ADJ ply OR Two\$1ply two ADJ ply "2"\$1ply "2" ADJ ply) AND (multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 AND TS750))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/21 05:35 PM
L75	1	74 NOT 72	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/08/21 05:35 PM
L76	0	((Multi\$1ply multi ADJ ply OR Two\$1ply two ADJ ply "2"\$1ply "2" ADJ ply) AND (multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE,	OR	ON	ON	2025/08/21 05:36 PM

		AND (TS7 AND TS750)).clm.	SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
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PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	0	((Multi\$1ply multi ADJ ply) AND (multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 AND TS750)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2025/08/20 10:55 PM
N2	0	((Multi\$1ply multi ADJ ply OR Two\$1ply two ADJ ply "2"\$1ply "2" ADJ ply) AND (multi\$1layer\$4 AND Multi ADJ layer\$4) AND (tissue towel wipe non\$wove non ADJ woven sheet web) WITH (non\$1WOOD\$4 NON ADJ WOOD\$4) AND (TS7 AND TS750)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2025/08/21 05:36 PM

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Initials

Title: Soft Sanitary Tissue Products Comprising Non-wood Fibers

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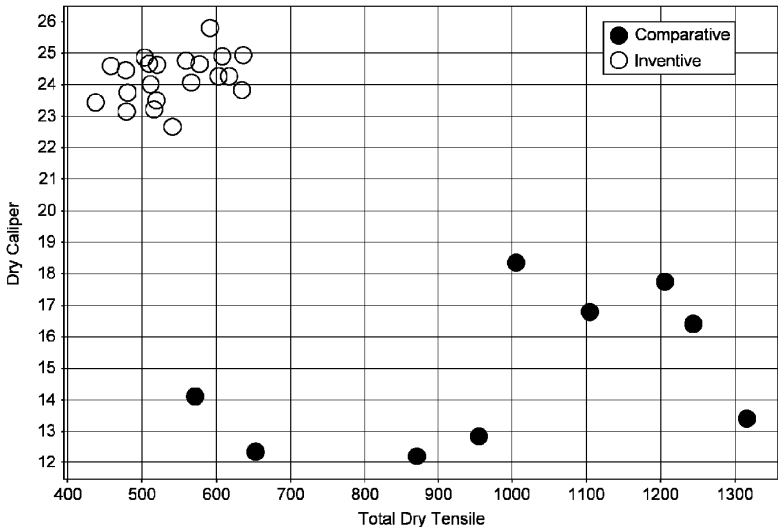


FIG. 1A

(57) Abstract: Sanitary tissue products of the present disclosure may comprise at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4, and may have one or a combination of premium performance parameter(s). One or more of said sanitary tissue products may form part of an array of sanitary tissue products.

[Continued on next page]

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PREMIUM SANITARY TISSUE PRODUCTS COMPRISING SHORT FIBERS

FIELD

The present disclosure generally relates to fibrous structures and, more particularly, to
5 fibrous structures comprising short fibers, including sanitary tissue products comprising eucalyptus
fibers.

BACKGROUND

The majority of sanitary tissue products are comprised of blends of softwood and
10 hardwoods. Softwoods will have much longer fiber lengths than hardwood fibers. Fibers sourced
from northern latitudes tend to have thinner cell walls than those of more southerly latitudes.
Northern softwood kraft fibers, in particular, lend themselves to creating tissue products, as their
long length and thin cell walls allow them to refine easily and create a strong fiber network on the
paper machine. Beyond softwoods, the papermaking industry has been using hardwoods or short
15 length fibers (e.g., eucalyptus) for many years and understands a lot about delivering desired
sanitary tissue product properties comprising short fibers; less, however, is understood about
delivering said properties with higher inclusion levels of short fibers, including embodiments
consisting solely of short fibers, (e.g., such as sanitary tissue products comprising greater than
65%, 70%, 80%, 90%, or 100% short fibers by weight). Accordingly, there is a need for
20 manufacturers to produce premium sanitary tissue products comprising higher inclusion levels of
short fibers. This is especially true since the use of NSK (a staple of current market sanitary tissue
products) is under increasing scrutiny due to its perceived environmental impact. It is therefore
desirable to develop a robust process that utilizes a low to zero inclusion NSK sanitary tissue
product.

25 Incorporating higher levels of eucalyptus fibers into sanitary tissue products is challenging
– the currently and previously marketed products comprising higher levels of eucalyptus fibers
evidence this because they generally don't perform well and don't have many of the high-tier
characteristics desired by consumers (e.g., desired tensile and/or tear properties). Several
references have disclosed (e.g., via patents) putting higher levels of eucalyptus into fibrous
30 structures, but don't inform as to how to achieve good performance. For instance, as evidenced in
FIGS. 18-1 through 18-5, toilet paper that are or have been marketed don't perform as well as many
users desire. All of this evidences that merely incorporating a higher percentage of eucalyptus, for
example, into a fibrous structure does not result in desired performance. There are several reasons

for the lack of desired properties, many of which are process related. Particularly, a web of short fibers often don't deflect well into a structuring belt; dry transfer is also a challenge, as is conveying the web to a reel. When studying the tables below, it reveals that one shouldn't expect desired characteristics and performance by merely substituting softwood fibers with short fibers. This is true despite that many of the comparative fibrous structures in the tables below are produced by experienced manufacturers and placed into the market for sale. Failure of these experienced paper manufacturers is also compelling evidence that making short fibers preform in premium ways in sanitary tissue products is not obvious. For these reasons, incorporation of short fibers (especially at higher inclusion levels) are not consumer-preferred as such can make the experience and perception of the resulting fibrous structure(s) (e.g., sanitary tissue products such as toilet tissue and paper towels) low quality, low-tier, and/or non-premium.

In contrast to this, the inventors of the present disclosure show surprisingly good results in key areas with sanitary tissue products comprising higher inclusions of short fibers, including, but not limited to tensile, tear, softness, strength, durability, coverage, absorption, friction, bulk, and roll properties. What is most impressive and difficult to accomplish is the combination of many of these parametrics at the same time in high inclusion short fiber tissue products - but the inventors herein have achieved this. Ultimately, the inventive embodiments of the present disclosure comprising material levels of short fibers seem similar (on their face) to previously disclosed embodiments, but the inventive embodiments herein are structurally different; thus, they perform differently.

Further, scaling factors are important in any system, including the making of sanitary products. One scale at play is the length scale. At the substrate level, length scale impacts several metrics, including, the substrate's caliper, bulk, density, compressibility, absorbency, tensile, etc. At the fiber level, which are the building blocks of the substrate, length scale impacts the fiber's length, width, and coarseness. So, when the length scale measures of fibers change significantly, one would expect the length scale measures of the substrates that are comprised of those fibers to materially change as well. Substrates of the present disclosure utilizing a high percentage of short fibers (i.e., comprising a low percentage of long fibers), however, exhibit premium consumer-desirable characteristics in the important areas of caliper, bulk, density, compressibility, tear, etc. even though their fiber length scale has been dramatically changed. Comparative substrates with like amounts of short fibers don't exhibit such premiumness due in part to length scale challenges; thus, inventive substrates of the present disclosure are superior over comparative substrates. Importantly, inventive substrates of the present disclosure also eliminate

or reduce compromises that the substrate developer usually needs to make in order for substrates comprising higher percentages of short fibers to be produced at scale and be consumer desirable.

As will be disclosed in greater detail below, the inventors of the present disclosure have found new ways of constructing, including designing and making, sanitary tissue structures and products that out-perform any of the known existing offerings that comprise relevant amounts of short fibers. For these reasons, even offerings consisting of short fibers, as disclosed herein, may be used to offer the premium characteristics the public desires of their fibrous structures. Further, sanitary tissue products of the present disclosure may, in many instances, be considered high-tier due to the desirable characteristics and/or performance that the inventors of the present disclosure have achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this disclosure, and the manner of attaining them, will become more apparent and the disclosure itself will be better understood by reference to the following description of non-limiting examples of the disclosure taken in conjunction with the accompanying drawings, wherein:

FIG. 1A is a Total Dry Tensile (x-axis) and dry caliper (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1B is a Total Dry Tensile (x-axis) and Compressive Modulus Slope (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1C is a Total Dry Tensile (x-axis) and Near-zero Load Caliper (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1D is a Total Dry Tensile (x-axis) and Compressive Modulus Slope (200g) (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1E is a Total Dry Tensile (x-axis) and Near-zero Load Caliper (200g) (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1F is a Total Dry Tensile (x-axis) and CD Elongation (Dry) (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1G is a Total Dry Tensile (x-axis) and CD Modulus (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1H is a Total Dry Tensile (x-axis) and MD Modulus (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1I is a Total Dry Tensile (x-axis) and Geometric Mean (GM) Dry Modulus (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1J is a Total Dry Tensile (x-axis) and CD Tear (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

5 FIG. 1K is a Total Dry Tensile (x-axis) and MD Tear (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1L is a Total Dry Tensile (x-axis) and GM Tear (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

10 FIG. 1M is a Total Dry Tensile (x-axis) and Flexural Rigidity (MD) (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1N is a Total Dry Tensile (x-axis) and VFS (g/g) (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1O is a Total Dry Tensile (x-axis) and Stack Compressibility (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

15 FIG. 1P is a Total Dry Tensile (x-axis) and Resilient Bulk (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 1Q is a Total Dry Tensile (x-axis) and Stack Compressibility x Resilient Bulk (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

20 FIG. 1R is a Total Dry Tensile (x-axis) and TS7 (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 2A is a Roll Bulk (x-axis) and Roll Compressibility (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

FIG. 2B is a Roll Bulk (x-axis) and Roll Firmness (y-axis) graph illustrating inventive tissue (bath) samples of FIGS. 18-1 through 18-5.

25 FIG. 3A is a photograph of a portion of a fibrous structure, particularly a paper towel, comprising short fiber(s) and comprising knuckles and pillows.

FIG. 3B is a photograph of a portion of a fibrous structure, particularly a WSO bath tissue, comprising short fiber(s) and comprising knuckles and pillows.

30 FIG. 3C is a photograph of a portion of a fibrous structure, particularly a FSO bath tissue, comprising short fiber(s) and comprising knuckles and pillows.

FIG. 4A is a representative cross-section view of a sanitary tissue product comprising knuckles and pillows and made according to a typical TAD process such as the one illustrated in FIG. 6A. In FIG. 4A, each ply 53 is fabric side out (FSO).

FIG. 4B is a representative cross-section view of a sanitary tissue product made according to an UCTAD process such as the one illustrated in FIGS. 6B and 6C – this sanitary tissue product does not have distinct knuckle and pillow regions or zones.

FIG. 4C is a representative cross-section view of a sanitary tissue product comprising
5 knuckles and pillows and made according to a typical TAD process such as the one illustrated in FIG. 6A. In FIG. 4C, ply 53 is wire side out (WSO) and ply 53' is FSO.

FIG. 4D is a representative cross-section view of a sanitary tissue product made according to an UCTAD process such as the one illustrated in FIGS. 6B and 6C– this sanitary tissue product does not have distinct knuckle and pillow regions or zones.

10 FIG. 4E is a representative cross-section view of a sanitary tissue product made according to an UCTAD process such as the one illustrated in FIGS. 6B and 6C– this sanitary tissue product does not have distinct knuckle and pillow regions or zones.

FIG. 4F is a representative cross-section view of a sanitary tissue product comprising knuckles and pillows and made according to a typical TAD process such as the one illustrated in
15 FIG. 6A.

FIG. 4G is a cross-section view of a sanitary tissue product made according to an UCTAD process such as the one illustrated in FIGS. 6B and 6C – this sanitary tissue product does not have distinct knuckle and pillow regions or zones.

FIG. 4H is a representative cross-section view of a sanitary tissue product made according
20 to a conventional wet press process – this sanitary tissue product does not have distinct knuckle and pillow regions or zones.

FIG. 4I is a representative cross-section view of a sanitary tissue product made according to a conventional wet press process – this sanitary tissue product does not have distinct knuckle and pillow regions or zones.

25 FIG. 5 is a plan view of a portion of a mask pattern used to make the papermaking belt that produced the fibrous structure of FIG. 3A.

FIG. 6A is a schematic representation of one method for making the new fibrous structures detailed herein. Specific details of the process and equipment represented by FIG. 6A can be found in U.S. Patent Nos. 5,714,041; 9,217,226; 9,435,081; 9,631,323; 9,752,281; 10,240,296; and U.S.
30 Publication Nos. 2013-0048239; 2022-0010497.

FIG. 6B is a schematic representation of one method for making the new fibrous structures detailed herein. Specific details of the process and equipment represented by FIG. 6B can be found in U.S. Patent No. 7,972,474.

FIG. 6C is a schematic representation of one method for making the new fibrous structures detailed herein.

FIG. 7 is a perspective view of a test stand for measuring roll compressibility properties as detailed herein.

5 FIG. 8 is perspective view of the testing device used in the roll firmness measurement detailed herein.

FIG. 9 is a diagram of an SST Test Method set up as detailed herein.

FIG. 10 is a schematic illustrating the Position of Gocator camera to a testing surface relating to the Moist Towel Surface Structure Method.

10 FIG. 11 is an enlarged view of a cell group overlapped by a quadrilateral related to the Continuous Region Density Difference Measurement.

FIG. 12 is a density image for use in the Micro-CT Intensive Property Measurement Method.

FIG. 13 is a binary image for use in the Micro-CT Intensive Property Measurement Method.

15 FIG. 14 is an example of a sample support rack used in the HFS and VFS Test Methods.

FIG. 14A is a cross-sectional view of the sample support rack of FIG. 14.

FIG. 15 is an example of a sample support rack cover used in the HFS and VFS Test Methods.

FIG. 15A is a cross-sectional view of the sample support rack cover of FIG. 15.

20 FIG. 16A is a portion of a fibrous structure of the present disclosure comprising an emboss pattern.

FIG. 16B is a portion of a fibrous structure of the present disclosure comprising an emboss pattern.

FIG. 17 is a representative papermaking belt of the kind useful to make fibrous structures comprising short fibers of the present disclosure.

FIGS. 18-1, 18-2, 18-3, 18-4, and 18-5 are five segments of a table that details multiple inventive and comparative sanitary tissue product embodiments.

DETAILED DESCRIPTION

30 Various non-limiting examples of the present disclosure will now be described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the fibrous structures comprising short fibers disclosed herein. One or more non-limiting examples are illustrated in the accompanying drawings. Those of ordinary skill in the art will understand

that the fibrous structures described herein and illustrated in the accompanying drawings are non-limiting examples. The features illustrated and/or described in connection with one non-limiting example can be combined with the features of other non-limiting examples. Such modifications and variations are intended to be included within the scope of the present disclosure.

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MAKING FIBROUS STRUCTURES OF THE PRESENT DISCLOSURE

“Machine Direction” or “MD” as used herein means the direction parallel to the flow of the fibrous structure through the papermaking machine and/or product manufacturing equipment.

“Cross Machine Direction” or “CD” as used herein means the direction perpendicular to
10 the machine direction in the same plane of the fibrous structure.

Generally, fibrous structures of the present disclosure are typically made in “wet-laid” papermaking processes. In such papermaking processes, a fiber slurry, usually wood pulp fibers, is deposited onto a forming wire and/or one or more papermaking belts such that an embryonic fibrous structure is formed. After drying and/or bonding the fibers of the embryonic fibrous
15 structure together, a fibrous structure is formed. Further processing of the fibrous structure can then be carried out after the papermaking process. For example, the fibrous structure can be wound on the reel and/or ply-bonded and/or embossed. As further discussed herein, visually distinct features may be imparted to the fibrous structures in different ways. In a first method, the fibrous structures can have visually distinct features added during the papermaking process. In a second
20 method, the fibrous structures can have visually distinct features added during the converting process (*i.e.*, after the papermaking process). Some fibrous structure examples disclosed herein may have visually distinct features added only during the papermaking process, and some fibrous structure examples may have visually distinct features added both during the papermaking process and the converting process.

25 Regarding the first method, a wet-laid papermaking process can be designed such that the fibrous structure has visually distinct features “wet-formed” during the papermaking process. Any of the various forming wires and papermaking belts utilized can be designed to leave physical, three-dimensional features within the fibrous structure. Such three-dimensional features are well known in the art, particularly in the art of “through air drying” (TAD) papermaking processes, with
30 such features often being referred to in terms of “knuckles” and “pillows.” “Knuckles” or “knuckle regions” or “knuckle zones” are typically relatively high-density regions that are wet-formed within the fibrous structure (extending from a pillow surface of the fibrous structure) and correspond to the knuckles of a papermaking belt, *i.e.*, the filaments or resinous structures that are

raised at a higher elevation than other portions of the belt. “Relatively high density” as used herein means a portion of a fibrous structure having a density that is higher than a relatively low-density portion of the fibrous structure. Relatively high density zones or regions can be about 30%, about 35%, about 40%, about 45%, about 50%, about 55%, about 60, or about 65% higher than relatively low density regions or zones. For instance, discrete knuckles, measured according to Micro-CT Intensive Property Measurement Method, may have a density greater than about (“greater than about” used interchangeably with “at least about” herein) 30%, about 35%, about 40%, about 45%, about 50%, about 55%, about 60, or about 65% higher than pillows. The majority of toilet tissue substrates are comprised of blends of softwood and hardwoods because each provides different characteristics and, thus, are used for different purposes. The long softwood fibers (preferably from northern latitudes) allow for strength and tear resistance of the substrate and create a network within which the shorter hardwood (e.g., eucalyptus) fibers reside. When a lot (or all) of the long fiber network is removed, the traditional mechanics are compromised. Further, scaling factors are important in any system, including the making of sanitary products. One scale at play is the length scale. At the substrate level the length scale comes into metrics, for example caliper, bulk, density, compressibility, absorbency, tear, etc. At the fiber level, which are the building blocks of the substrate, the length scale comes into play in measures such as fiber length, width, and coarseness. When the length scale measures of fibers change significantly one would expect the length scale measures of the substrates that are comprised of those fibers to change as well. are some of the reasons that incorporation of a high percentage of short fibers into established sanitary tissue products is not straightforward and creates unexpected outcomes. This is especially true as one tries to achieve parity (when using high percentages of short fibers) for multiple key parameters of sanitary tissue products.

Likewise, “pillows” or “pillow regions” or “pillow zones” are typically relatively low-density regions that are wet-formed within the fibrous structure and correspond to the relatively open regions between or around the knuckles of the papermaking belt. The pillow regions form a pillow surface of the fibrous structure from which the knuckle regions extend. “Relatively low density” as used herein means a portion of a fibrous structure having a density that is lower than a relatively high-density portion of the fibrous structure. Further, the knuckles and pillows wet-formed within a fibrous structure can exhibit a range of basis weights and/or densities relative to one another, as varying the size of the knuckles or pillows on a papermaking belt can alter such basis weights and/or densities. A fibrous structure (e.g., sanitary tissue products) made through a TAD papermaking process as detailed herein is known in the art as “TAD paper.”

Thus, in the description herein, the terms “knuckles” or “knuckle regions” or “knuckle zones” or the like can be used to reference either the raised portions of a papermaking belt or the densified, raised portions wet-formed within the fibrous structure made on the papermaking belt (*i.e.*, the raised portions that extend from a surface of the fibrous structure), and the meaning should be clear from the context of the description herein. Likewise “pillows” or “pillow regions” or “pillow zones” or the like can be used to reference either the portion of the papermaking belt between or around knuckles (also referred to in the art as “deflection conduits” or “pockets”), or the relatively uncompressed regions wet-formed between or around the knuckles within the fibrous structure made on the papermaking belt, and the meaning should be clear from the context of the description herein. Knuckles or pillows can each be either continuous or discrete, as described herein. As shown in FIGS. 5, such illustrated masks may be used in producing papermaking belts that would create fibrous structures that have discrete knuckles and continuous/substantially continuous pillows. Like masks may be used in producing papermaking belts that would create fibrous structures that have discrete pillows and continuous/substantially continuous knuckles. The term “discrete” as used herein with respect to knuckles and/or pillows means a portion of a papermaking belt or fibrous structure that is defined or surrounded by, or at least mostly defined or surrounded by, a continuous/substantially continuous knuckle or pillow. The term “continuous/substantially continuous” as used herein with respect to knuckles and/or pillows means a portion of a papermaking belt or fibrous structure network that fully, or at least mostly, defines or surrounds a discrete knuckle or pillow. Further, the substantially continuous member can be interrupted by macro patterns formed in the papermaking belt, as disclosed in US Pat. No. 5,820,730 issued to Phan et al. on October 13, 1998.

Knuckles and pillows in paper towels (also referred to as “towel”) and bath tissue (also referred to as “toilet tissue,” “bath,” or “toilet paper”) can be visible to the retail consumer of such products. The knuckles and pillows can be imparted to a fibrous structure from a papermaking belt at various stages of the papermaking process (*i.e.*, at various consistencies and at various unit operations during the drying process) and the visual pattern generated by the pattern of knuckles and pillows can be designed for functional performance enhancement as well as to be visually appealing. Such patterns of knuckles and pillows can be made according to the methods and processes described in US. Pat. No. 6,610,173, issued to Lindsay et al. on August 26, 2003, or US Pat. No. 4,514,345 issued to Trokhan on April 30, 1985, or US Pat. No. 6,398,910 issued to Burazin et al. on June 4, 2002, or US Pub. No. 2013/0199741; published in the name of Stage et al. on August 8, 2013. The Lindsay, Trokhan, Burazin and Stage disclosures describe belts that are

representative of papermaking belts made with cured resin on a woven reinforcing member, of which aspects of the present disclosure are an improvement. But in addition, the improvements detailed herein can be utilized as a fabric crepe belt as disclosed in US Pat. No. 7,494,563, issued to Edwards et al. on Feb. 24, 2009 or US 8,152,958, issued to Super et al. on April 10, 2012, as well as belt crepe belts, as described in US Pat. No. 8,293,072, issued to Super et al on October 23, 2012. When utilized as a fabric crepe belt, a papermaking belt of the present disclosure can provide the relatively large, recessed pockets and sufficient knuckle dimensions to redistribute the fiber upon high impact creping in a creping nip between a backing roll and the fabric to form additional bulk in conventional wet-laid press processes. Likewise, when utilized as a belt in a belt crepe method, a papermaking belt of the present disclosure can provide the fiber enriched dome regions arranged in a repeating pattern corresponding to the pattern of the papermaking belt, as well as the interconnected plurality of surrounding areas to form additional bulk and local basis weight distribution in a conventional wet-laid process. In addition, the improvements detailed herein, can be utilized as an uncreped through air dried (UCTAD) belt. UCTAD (un-creped through air drying) is a variation of the TAD process in which the sheet is not creped, but rather dried up to 99% solids using thermal drying, removed from the structured fabric, and then optionally calendered and reeled. U.S. Pat. No. 6,808,599 describes an uncreped through air dried process. U.S. Pat. No. 10,610,063 describes an uncreped through air dried product made using a belt. In addition, the improvements herein can be utilized as an ATMOS belt. The ATMOS process has been developed by the Voith company and marketed under the name ATMOS. The process/method and paper machine system has several variations, but all involve the use of a structured fabric in conjunction with a belt press. This process is described in numerous patent publications including U.S. Pat. Nos. 7,510,631, 7,686,923, 7,931,781, 8,075,739, and 8,092,652. In addition, the improvements herein can be utilized as an NTT belt. The NTT process has been developed by the Metso company and marketed under the name NTT. The NTT process includes an extended press nip where the sheet is transferred from a press felt onto a texturing belt. Examples of texturing belts used in the NTT process can be viewed in International Publication Number WO 2009/067079 A1 and US Patent Application Publication No. 2010/0065234 A1. An example of a papermaking belt structure of the general type useful in the present disclosure and made according to the disclosure of US Pat. No. 4,514,345 is shown in FIG. 17. As shown, the papermaking belt 17 can include cured resin elements 4 forming knuckles 20 on a woven reinforcing member 6. The reinforcing member 6 can be made of woven filaments 8 as is known in the art of papermaking belts, for example resin coated papermaking belts. The papermaking

belt structure shown in FIG. 17 includes discrete knuckles 20 and a continuous deflection conduit, or pillow region (pillow zone). The discrete knuckles 20 can wet-form densified knuckles within the fibrous structure made thereon; and, likewise, the continuous deflection conduit, *i.e.*, pillow region, can wet-form a continuous pillow region within the fibrous structure made thereon. The knuckles can be arranged in a pattern described with reference to an X-Y coordinate plane, and the distance between knuckles 20 in at least one of the X or Y directions can vary according to the examples disclosed herein. For clarity, a fibrous structure's visually distinct knuckle(s) and pillow(s) that are wet-formed in a wet-laid papermaking process are different from, and independent of, any further structure added to the fibrous structure during later, optional, converting processes (e.g., one or more embossing process). For certain embodiments of the present disclosure, it may be desirable to use the belts disclosed in U.S. Patent Nos. 9,435,081; 9,631,323; 9,752,281; 10,240,296; and U.S. Publication Nos. 2022-0010497; and 2021-0140114 as some of these belts create sinusoidal and/or serpentine pillow and/or knuckle regions or zones; in some embodiments, these pillow and/or knuckle zones or regions may be continuous and/or semi-continuous. These patterns referenced in the patents and publication of the previous sentence can be particularly useful for achieving the most desirable properties from webs comprising short fibers, even including high short fiber inclusion.

After completion of the papermaking process, a second way to provide visually distinct features to a fibrous structure is through embossing. Embossing is a well-known converting process in which at least one embossing roll having a plurality of discrete embossing elements extending radially outwardly from a surface thereof can be mated with a backing, or anvil, roll to form a nip in which the fibrous structure can pass such that the discrete embossing elements compress the fibrous structure to form relatively high density discrete elements ("embossed regions") in the fibrous structure while leaving an uncompressed, or substantially uncompressed, relatively low density continuous, or substantially continuous, network ("non-embossed regions") at least partially defining or surrounding the relatively high density discrete elements.

As illustrated in FIGS. 6B and 6C, beyond creating knuckles and pillows with resinous belts described above, and beyond the various types of creping, paper may be transformed in other ways, such that beneficial properties are created, especially as the speed of a belt or a wire transfers the web to a belt or a wire of a different speed, such as, for example, the upstream belt or wire moving faster than the downstream belt or wire. It may be desirable to have multiple such transfers in the same papermaking process. Further, it may be desirable to have different speed differentials at different transfers in such a process. As a more specific example, referring to FIG. 6B, in a first

rush transfer 175, the speed of the forming fabric 154 can be travelling at a first rate, while the transfer fabric 174 travels at a second rate (slower than the first rate, but faster than 2,000 feet per minute (fpm), 2,050 fpm, 2,100 fpm, 2,150 fpm, 2,200 fpm, 2,250 fpm, 2,300 fpm, 2,350 fpm, 2,400 fpm, 2,450 fpm, 2,500 fpm, 2,600 fpm, 2,700 fpm, 2,800 fpm, 2,900 fpm, or greater than 5 3,000 fpm); further, a second rush transfer 175' may occur where the transfer fabric is travelling at the second rate, while the TAD fabric 164 travels at a third rate, which may be the faster or slower (e.g., about 10%, about 15%, about 20%, about 25%, about 30%, about 40, about 50% faster or slower) than the second rate. While the UCTAD process does not form traditional density differentials (e.g., such as knuckles and pillows), said rush transfers can, depending on the speed 10 differentials of the transfers, create fiber orientations within the web such that performance of the fibrous structure is improved, such as, for example, stretch, tensile ratio, tensile, modulus, caliper, bulk.

Embossed features in paper towels and bath tissues can be visible to the retail consumer of such products. Emboss designs as disclosed in U.S. Design. Pat. App. Nos. 29/673,106; 15 29/673,105; and 29/673,107 may be used to make fibrous structures of the present disclosure. Emboss patterns can be made according to the methods and processes described in US Pub. No. US 2010-0028621 A1 in the name of Byrne et al. or US 2010-0297395 A1 in the name of Mellin, or US Pat. No. 8,753,737 issued to McNeil et al. on June 17, 2014. For clarity, such embossed features originate during the converting process, and are different from, and independent of, the 20 pillow and knuckle features that are wet-formed on a papermaking belt during a wet-laid papermaking process.

More particular papermaking processes are disclosed below and illustrated in FIGS. 6A and 6B, versus the more general description above. FIGS. 6A and 6B are simplified, schematic representations of continuous fibrous structure making processes and machines useful in the 25 practice of the present disclosure. The following description of the process and machine include non-limiting examples of process parameters useful for making a fibrous structure of the present invention.

As shown in FIG. 6A, process and equipment 150 for making fibrous structures according to the present disclosure comprises supplying an aqueous dispersion of fibers (a fibrous furnish) 30 to a headbox 152 which can be of any design known to those of skill in the art. The aqueous dispersion of fibers can include wood and non-wood fibers, northern softwood kraft fibers ("NSK"), eucalyptus fibers, southern softwood kraft (SSK) fibers, Northern Hardwood Kraft (NHK) fibers, acacia, bamboo, straw and bast fibers (wheat, flax, rice, barley, etc.), corn stalks,

bagasse, abaca, kenaf, reed, synthetic fibers (PP, PET, PE, bico version of such fibers), regenerated cellulose fibers (viscose, lyocell, etc.), and other fibers known in the papermaking art, including “short fibers” having an average length of 1.0 mm or less (length weighted mean fiber length) and including “long fibers” having an average length greater than 1.0 mm (length weighted mean fiber length), from about 1.2 mm to about 3.5 mm, or from about 3 mm to about 10 mm. Depending on the fibers being used, they may be in the long fiber range of length. For instance, bamboo can have a length from 1.1 to 2.0 mm and sunn hemp is even longer, it can have a length from 2.8 to 3.0 mm and sisal hemp can have a length from 2.5 to 2.7 mm. Kenaf can have a length from 2.7 to 3.0 mm, abaca can have a length from 4.0 to 4.3 mm. This becomes significant when long fibers are replaced with short fibers like short fibers.

From the headbox 152, the aqueous dispersion of fibers can be delivered to a foraminous member 154, which can be a Fourdrinier wire, to produce an embryonic fibrous web 156. Furnish mixes may be useful in the present disclosure may be from about 20% to about 50% short fibers and from about 40% to about 100% long fibers, specifically including all 1% increments between the recited ranges.

The foraminous member 154 can be supported by a breast roll 158 and a plurality of return rolls 160 of which only two are illustrated. The foraminous member 154 can be propelled in the direction indicated by directional arrow 162 by a drive means, not illustrated, at a predetermined velocity, V_1 . Optional auxiliary units and/or devices commonly associated with fibrous structure making machines and with the foraminous member 154, but not illustrated, comprise forming boards, hydrofoils, vacuum boxes, tension rolls, support rolls, wire cleaning showers, and other various components known to those of skill in the art.

After the aqueous dispersion of fibers is deposited onto the foraminous member 154, the embryonic fibrous web 156 is formed, typically by the removal of a portion of the aqueous dispersing medium by techniques known to those skilled in the art. Vacuum boxes, forming boards, hydrofoils, and other various equipment known to those of skill in the art are useful in effectuating water removal. The embryonic fibrous web 156 can travel with the foraminous member 154 about return roll 160 and can be brought into contact with a papermaking belt 164 in a transfer zone 136, after which the embryonic fibrous web travels on the papermaking belt 164. While in contact with the papermaking belt 164, the embryonic fibrous web 156 can be deflected, rearranged, and/or further dewatered. Depending on the process, mechanical and fluid pressure differential, alone or in combination, can be utilized to deflect a portion of fibers into the deflection conduits of the papermaking belt. For example, in a through-air drying process a vacuum apparatus

176 can apply a fluid pressure differential to the embryonic web 156 disposed on the papermaking belt 164, thereby deflecting fibers into the deflection conduits of the deflection member. The process of deflection may be continued with additional vacuum pressure 186, if necessary, to even further deflect and dewater the fibers of the web 184 into the deflection conduits of the papermaking belt 164.

The papermaking belt 164 can be in the form of an endless belt. In this simplified representation, the papermaking belt 164 passes around and about papermaking belt return rolls 166 and impression nip roll 168 and can travel in the direction indicated by directional arrow 170, at a papermaking belt velocity V_2 , which can be less than, equal to, or greater than, the foraminous member velocity V_1 . In the present disclosure, the papermaking belt velocity V_2 is less than foraminous member velocity V_1 such that the partially-dried fibrous web is foreshortened in the transfer zone 136 by a percentage determined by the relative velocity differential between the foraminous member and the papermaking belt. Associated with the papermaking belt 164, but not illustrated, can be various support rolls, other return rolls, cleaning means, drive means, and other various equipment known to those of skill in the art that may be commonly used in fibrous structure making machines.

The papermaking belts 164 of the present disclosure can be made, or partially made, according to the process described in U.S. Patent No. 4,637,859, issued Jan. 20, 1987, to Trokhan, and having the patterns of cells as disclosed herein.

The fibrous web 192 can then be creped with a creping blade 194 to remove the web 192 from the surface of the Yankee dryer 190 resulting in the production of a creped fibrous structure 196 in accordance with the present disclosure. As used herein, creping refers to the reduction in length of a dry (having a consistency of at least about 90% and/or at least about 95%) fibrous web which occurs when energy is applied to the dry fibrous web in such a way that the length of the fibrous web is reduced and the fibers in the fibrous web are rearranged with an accompanying disruption of fiber-fiber bonds. Creping can be accomplished in any of several ways as is well known in the art, as the doctor blades can be set at various angles. The creped fibrous structure 196 is wound on a reel, commonly referred to as a parent roll, and can be subjected to post processing steps such as calendaring, tuft generating operations, embossing, and/or converting. The reel winds the creped fibrous structure at a reel surface velocity, V_4 .

The papermaking belts of the present disclosure can be utilized to form discrete elements and a continuous/substantially continuous network (*i.e.*, knuckles and pillows) into a fibrous structure during a through-air-drying operation. The discrete elements can be knuckles and can be

relatively high density relative to the continuous/substantially continuous network, which can be a continuous/substantially pillow having a relatively lower density. In other examples, the discrete elements can be pillows and can be relatively low density relative to the continuous/substantially continuous network, which can be a continuous/substantially continuous knuckle having a relatively higher density. In the example detailed above, the fibrous structure is a homogenous fibrous structure, but such papermaking process may also be adapted to manufacture layered fibrous structures, as is known in the art. As discussed above, the fibrous structure can be embossed during a converting operation to produce the embossed fibrous structures of the present disclosure.

10 Refining

Fiber to fiber bonding is typically improved through refining - a mechanical process that modifies the fibers. It is believed that the mechanical energy from refining delaminates cell walls, externally fibrillates the fibers, and releases hemicellulose based gels, which improve the relative bonded area between fibers and the overall strength of the substrate. This increase in strength, however, is often at the cost of decreased softness, which can be described via tensile modulus. High tensile moduli are associated with lower softness sheets. Additionally, the strength of the fiber itself is typically a function of fiber cell wall thickness and fiber diameter.

Refining plates can be used that are specifically designed to refine hardwood fibers. These plates typically have a greater number of bars present in them, with smaller grooves in between. The combination of many bars allows for a lower level of refining intensity (characterized by units of power per unit length-joule/meter) that allow a more delicate short fiber to be appropriately refined while not causing high levels of fines or fiber destruction. The act of refining increases the external and internal fibrillation of fibers, increasing their surface area and receptivity to adsorption of various strength enhancing polymers.

This low intensity refining of eucalyptus, rapidly followed by layered strength chemistries (Redibond-CMC), combined with an unrefined eucalyptus stream in a layered substrate can allow the sheet to be reliably conveyed to the reel of the paper machine after the creping blade (when one is used) without sheet tears or breaks.

30 Enzymes

In addition to or as an alternative to refining, fiber bonding can be improved by use of enzymes. For example, US6635146 describes the use of certain hydrolytic enzymes that create

aldehyde groups on the fiber surfaces. They report that “paper or tissue made from these fibers alone, or made from blends of these fibers with untreated pulp fibers, show an increase in strength properties such as dry tensile, wet tensile, tear, z-direction tensile (surface integrity), etc.”

5 Further, US10422082 states that “Cellulases can be used to modify the surface of the cellulose molecules, which are contained in the fibers used to make absorbent structures, and disrupt the crystalline structure of the cellulose to fibrillate the fiber, thereby enhancing the fiber to fiber bonding during web formation and the final strength of the absorbent structure. The ability to provide enhanced fibrillation and fiber to fiber bonding can limit or eliminate the need
10 for mechanical refining to fibrillate the fiber, which can reduce bulk, absorbency, and softness of the absorbent structure... Without being bound by theory ... the cellulase provides enhanced fibrillation and fiber to fiber bonding so that mechanical refining can be minimized or eliminated.”

15 Biopolymers

Fiber bonding can also be improved by the use of additives in the pulping process – such as biopolymers as described in US11047092 and family. In these publications, the inventors state that they “have noticed that the addition of these biopolymers specifically developed for the process of the present invention can differentiate pulps properties, particularly cellulose pulps of
20 eucalyptus, with a substantial increase in tensile strength, tear resistance, drainability, and air permeability, among other important and desired properties. This enables differentiated and innovative applications, and the possibility of using more short fibers instead of the long fibers, and can result in improvements in plant productivity or energy savings because it facilitates pulp dewatering in the drying stage.”

25

Water Removal

The location of water removal along the paper-making machine can be important when making premium substrates comprising high levels of short fiber inclusion. During the making process, while the web (or sheet) is evenly supported on the wire, it may be desirable to remove enough
30 water from it by using appropriately staged vacuums so that when the sheet is transferred to a more textured (and lower sheet supporting) TAD belt, it can be removed after the through air dryers and then, when applicable, applied to the Yankee. Conversely, there should be enough

water present when transferring the sheet to the TAD fabric, such that out-of-plane dewatering forces at wet transfer can deflect the sheet into the pillow and/or lower cavities of the TAD fabric; this can regionally effect specific properties of the substrate, such as bulk or density. The range of acceptable water removal is largely a function of the long fiber present in the sheet.

- 5 Traditional (or conventional) premium furnish mixes (e.g., 65% short fiber) can have an acceptable dewatering range between about 2.2 and 3.7 pounds of water per pound of fiber. Increasing the short fiber composition to 75% lowers this range to between about 1.9 and 2.9. Increasing the short fiber composition to 85% further lowers this range to about 1.2 to 1.6. Increasing the short fiber composition to 95% further lowers this range to about 0.3 to 1.0.
- 10 Increasing the short fiber composition to 100% further lowers this range to about 0.2 to 0.6 pounds of water per pound of fiber. Heavy wire dewatering and minimal water removal at wet transfer are ways to allow for a sheet that is comprised primarily of short fibers to be deflected into a TAD/structuring belt while also, when employing a Yankee, being successfully removed during dry transfer to the Yankee.

15

In-process Tensile and Tear

- There are several characteristics to quantify the strength of a substrate. Two of those characteristics are tensile strength and tear strength. Tensile strength measures in-plane forces and is known to be a strong function of fiber-to-fiber bonding. Tear strength measures the
- 20 propensity of an initiated tear to propagate through a sheet; it is known by practitioners to be a function of both fiber-to-fiber bonding and fiber length, as longer fibers can be bonded in multiple spots on a sheet. As the percentage of long fiber in a sheet goes up, the tear strength of the sheet goes up, even at a constant tensile. Both of these metrics are important for the reliable operation of a paper machine, especially those with unsupported webs. This is because even if a
- 25 sheet has sufficient tensile strength to span a length of the machine or endure a unit operation such as creping, if there are any imbalances or imperfections in the sheet or machine, that imperfection can then cause a tear that extends across the entire web of the machine and causes a break, decreasing the operational efficiency of the machine.

- The creping action of a Yankee containing tissue machine is particularly sensitive to the tear
- 30 characteristics of the sheet. Sheet adhesion to the Yankee, glue characteristics, creping pocket geometry, and downstream draws all combine to impart significant energy into the sheet at this point. Any imperfections in how that energy is imparted, or imperfections in the sheet, may initiate

a tear that would cause the sheet to break while in production. This issue is exacerbated when making TAD and/or structured paper due to the fact that the knuckles/top of the structuring fabric is pressed with more force to the Yankee in the dry transfer nip. This causes gradients in adhesion of the sheet to the Yankee, which can cause tear propagation at the creping blade.

5

Chemistry

Neutral to alkaline pH cellulose fibers are anionically charged. Therefore, it is common to apply cationically promoted natural and synthetic polymers to the fibers in the approach system of a paper machine to allow for better bonding of the fibers in the final substrate. Additional layers of polymers with an opposite charge can be applied and retained on the fiber due to electrostatic attraction. The intentional choices of polymer type, amount, and application point can be important to allow for good retention and efficacy of the chemistry in the final product.

10

Layering

As mentioned previously, the act of properly selecting refining conditions and the judicious application of chemistries can greatly improve sheet properties in a substrate, such as tensile and/or tear. These processes and chemistries can then be selectively layered such that in the final web, layers that are more heavily refined or with more chemistry can be hidden from the consumer. This also allows a substrate designer to place softer, less refined, and lower chemistry added fibers closer to the consumer. This allows the substrate designer to create substrates that are both strong and soft, and allows for the creation of premium products with the use of less (than traditional) to no long fibers in the sheet.

20

Refining of short fibers (e.g., eucalyptus) may be followed by (in some cases rapidly) layered strength chemistries (e.g., Redibond-CMC). These layered strength chemistries may be combined with an unrefined eucalyptus stream in a layered substrate. Further, it may be desirable to use heavy wire dewatering to create a combination of refining, layer strength chemistry(ies) (e.g., Redibond-CMC), and belt selection to allow for a number of consumer desirable physical properties using a furnish mix comprised heavily of (or solely of) very fast growing short fibers (e.g., eucalyptus).

25

Referring to FIGS. 4A through 4I, it may be desirable to form a multi-layered sanitary tissue ply, where at least one layer of the ply comprises refined, short fibers and at least one layer of the ply comprises un-refined, short fibers. Further, it may be desirable to alternate the layers comprising refined and un-refined short fibers. Still further, it may be desirable to apply one or

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more strength chemistries (including natural and synthetic polymers) to the layer comprising un-refined short fibers. Natural polymers include starch (cationic/anionic starch) and gums (guar gum, for example) and synthetic polymers comprise polyacrylamide and its derivatives, polyvinyl alcohol, etc.).

5

Perforations

A key step in the conversion of single ply parent rolls into single or multiply finished product rolls that are intended for final consumer use is the perforation process. In this process, the web(s) enter rotary knives that are sectioned to create failure points along the web. The purpose of these failure points is to divide the finished product rolls into sheets for dispensing by the final user.

The distance between the notches and the teeth in the perforation blade, and the relative size of both of those features, is important. Given that a sanitary tissue web is comprised of fibers, the size of the fibers is important in the perforation system as well. Key metrics in a perforation system include perforation tensile, perforation elongation, and perforation TEA. It has been found that at a given percent bonded area of a perforation, there is a strong relationship between the weight weighted mean fiber length of a substrate and the length of the land area in a perforation. Specifically, at a given bond area, as the size of the lands (and therefore perforation size as well) goes down, the tensile, stretch, or TEA of the web perforation goes up. This phenomenon is amplified as the weight weighted mean fiber length of the substrate goes down.

It is hypothesized that the cause for strong dependence between perforation land size, weight weighted mean fiber length, and perforation performance is rooted in the commonly known relationship between fiber length and tear. In this relationship, at a given tensile strength, as the inclusion of long fibers goes up in substrate, the tear increases. This is thought to be that long fibers have the ability to bond in multiple parts of the sheet, and at distances that are farther from the point of tear, due to their longer length. This then increases the force required to continue to propagate the tear, as the longer fibers must either be torn themselves or fail in multiple locations in the sheet as they are pulled out. This logic would apply to a perforation land as well, where the tear propagates to the end of land before reaching the perforation. In a system with lots of long fibers, the force is distributed due to the fiber length, so the importance of land size at a given bond area is somewhat muted, but in a substrate with lots of short fibers, the rapid tear propagation occurs all the way across the land and then stops at a perforation, and may pick up again on the next land or be delayed. This tear pause induced by the high frequency

of perforations has the net effect of increasing the perf tensile, elongation, and TEA of a perforation preferentially for substrates with low weight weighted fiber lengths.

STRUCTURES OF THE PRESENT DISCLOSURE

5 “Fiber” as used herein means an elongate physical structure having an apparent length greatly exceeding its apparent diameter, i.e., a length to diameter ratio of at least about 10. Fibers having a non-circular cross-section and/or tubular shape are common; the “diameter” in this case may be considered to be the diameter of a circle having cross-sectional area equal to the cross-sectional area of the fiber. More specifically, as used herein, “fiber” refers to fibrous structure-making fibers. The present disclosure contemplates the use of a variety of fibrous structure-making fibers, such as, for example, naturally-occurring fibers (wood and non-wood), synthetic (human-made) fibers, and/or any other suitable fibers, and any combination thereof.

10 “Fibrous structure” as used herein means a structure that comprises a plurality of fibers. In one example, a fibrous structure according to the present disclosure means an orderly arrangement of fibers within a structure in order to perform a function. A bag of loose fibers is not a fibrous structure in accordance with the present disclosure. The terms “web,” “fibrous web,” “embryonic web,” and “embryonic fibrous web” are used to describe the web that is in the process of becoming the fibrous structure. Further, fibrous structures may be rolled, interleaved, perforated, and/or packaged to form final product(s), such as a sanitary tissue product.

15 “Non-woven fibrous structure” as used herein means a fibrous structure wherein fibers forming the fibrous structure are not orderly arranged by weaving and/or knitting the fibers together. In other words, non-woven fibrous structures do not include textiles, garments, and/or apparel. The non-woven fibrous structures of the present disclosure are disposable (i.e., typically thrown away after one or two uses—unlike clothes, rags, cloths, etc.).

20 “Ply” or “Plies” as used herein means an individual fibrous structure optionally to be disposed in a substantially contiguous, face-to-face relationship with other plies, forming a multiple ply fibrous structure. It is also contemplated that a single fibrous structure can effectively form two “plies” or multiple “plies”, for example, by being folded on itself. A ply may comprise multiple layers. Multiple plies may, for example be formed as follows: fibrous structure of the present disclosure may be combined with one or more additional fibrous structures, which is the same or different from the fibrous structures of the present disclosure to form a multi-ply sanitary tissue product; said additional fibrous structure may be combined with the fibrous structure of the present disclosure by any suitable means.

“Sanitary tissue product” as used herein means a soft, low density (i.e., <about 0.25 g/cm³) fibrous structure useful as a wiping implement for post-urinary and post-bowel movement cleaning (toilet tissue), for otorhinolaryngological discharges (facial tissue), and multi-functional absorbent and cleaning uses (absorbent towels and napkins). The sanitary tissue product may be convolutedly wound upon itself about a core or without a core to form a roll of sanitary tissue product. Further, the fibrous structure making up the sanitary tissue product may be perforated to form interconnected sheets. Sanitary tissue products may consist of fibers having an average length of less than about 1 inch; further sanitary tissue products may not comprise any fibers (or filaments) having a length greater than 1 inch. Sanitary tissue products may be formed according to a wet-laid process as illustrated in FIGS. 6A-C.

“Clothlike” as used herein relates to the feel of the non-woven fibrous structure to a consumer, the appearance of the non-woven fibrous structure to a consumer, and/or the performance (e.g., absorbency, strength, durability, etc.) of the non-woven fibrous structure during use by a consumer.

“Lint” as used herein means any material that originated from a fibrous structure according to the present disclosure that remains on a surface after which the fibrous structure and/or sanitary tissue product has come into contact. The lint value of a fibrous structure and/or sanitary tissue product comprising such fibrous structure is determined according to the Lint Test Method described herein.

“Differential density,” as used herein, means a fibrous structure and/or sanitary tissue product that comprises one or more regions of relatively low fiber density, which are referred to as pillow regions, and one or more regions of relatively high fiber density, which are referred to as knuckle regions. In one example, a fibrous structure of the present disclosure comprises a surface comprising a surface pattern comprising a continuous knuckle region and a plurality of discrete pillow regions that exhibit different densities, for example, one or more of the discrete pillow regions may exhibit a density that is different (e.g., 30% different) than the density of the continuous knuckle region.

“Densified,” as used herein means a portion of a fibrous structure and/or sanitary tissue product that is characterized by regions of relatively high fiber density (knuckle regions).

“Non-densified,” as used herein, means a portion of a fibrous structure and/or sanitary tissue product that exhibits a lesser density (one or more regions of relatively lower fiber density) (pillow regions) than another portion (for example a knuckle region) of the fibrous structure and/or sanitary tissue product.

“Dry fibrous structure” as used herein means that the fibrous structure exhibits a water content (% moisture) of less than 20% and/or less than 15% and/or less than 10% and/or less than 7% and/or less than 5% and/or less than 3% and/or less than 1% to 0% and or to greater than 0%. Water content (% moisture) of a fibrous structure is measured using an Ohaus MB45 moisture
5 balance, or an equivalent instrument, set to a drying temperature of 130°C, with moisture determined after the weight changes less than 1mg in 60 seconds (A60 hold time). Dry fibrous structures of the present disclosure may exhibit a water content (% moisture) of from about 0.0001% to about 20% and/or from about 0.001% to about 15% and/or from about 0.001% to about 12% and/or from about 0.001% to about 10% and/or from about 0.001% to about 7% and/or from
10 about 0.001% to about 5%, by weight of the dry fibrous structure.

“Stacked product(s)” as used herein include fibrous structures, paper, and sanitary tissue products that are in the form of a web and cut into distinct separate sheets, where the sheets are folded (e.g., z-folded or c-folded) and may be interleaved with each other, such that a trailing edge of one is connected with a leading edge of another. Common examples of stacks of folded and/or
15 interleaved sheets include facial tissues and napkins.

“Percent (%) difference,” “X% difference,” or “X% different” is calculated by: subtracting the lower value (e.g., common intensive property value) from the higher value (e.g., common intensive property value) and then dividing that value by the average of the lower and higher values, and then multiplying the result by 100.

20 “Within X%” or “within X percent” is calculated by the following non-limiting example: If first and second sanitary tissue products have a common intensive property (e.g., lint), and if a second lint value of the second sanitary tissue product is 10, then “within 25%” of the second lint value is calculated as follows for this example: multiplying 10 (the second lint value) by 25%, which equals 2.5, and then adding 2.5 to 10 (the second lint value) and subtracting 2.5 from 10 (the
25 second lint value) to get a range, so that “within 25%” of the second lint value for this example means a lint value of or between 12.5 and 7.5). The absolute value of “X% change” can be used to determine if “within X%” is satisfied; for example can also be determined by using the absolute For example, if “X% change” is -25%, then a “within 25%” is satisfied, but if “X% change” is -25%, a “within 20%” is not satisfied.

30 “Percent (%) change,” “X% change,” or “X% change” is calculated by: subtracting the reference value (e.g., common intensive property value of a sustainable sanitary tissue product) from the comparative value (e.g., common intensive property value of a sanitary tissue product) and then dividing by the reference value, and then multiplying the result by 100. For example, if a

reference value is 18 (e.g., a basis weight of a sustainable sanitary tissue product) and the comparative value is 31 (e.g., a basis weight of a soft sanitary tissue product), then 18 should be subtracted from 31, which equals 13, which should be divided by 18, which equals 0.722, which should be multiplied by 100, which equals 72.2% change.

5 Fibrous structures of the present disclosure may be used to make sanitary tissue products, including paper towels, bath tissues, napkins, and facial tissues. The fibrous structures can be single-ply or multi-ply and may comprise cellulosic pulp fibers.

 Fibrous structures of the present disclosure may be selected from the group consisting of: through-air-dried fibrous structures, differential density fibrous structures, differential basis weight
10 fibrous structures, wet laid fibrous structures, air laid fibrous structures, conventional dried fibrous structures, creped or uncreped fibrous structures, patterned-densified or non-patterned-densified fibrous structures, compacted or uncompacted, especially high bulk uncompacted, fibrous structures, other nonwoven fibrous structures comprising synthetic or multicomponent fibers, homogeneous or multilayered fibrous structures, double re-creped fibrous structures, uncreped
15 fibrous structures, co-form fibrous structures and combinations thereof.

 As shown in FIGS. 3A-3C, fibrous structures and/or sanitary tissue products of the present disclosure may comprise a surface that comprises undulations (e.g., knuckles 20 and pillows 22) and/or embossments (e.g., 32, 34). FIGS. 16A and 16B illustrate embossments 32 (where each line and dot illustrated in FIGS. 16A and 16B is an embossment) that may be desirable for use with
20 fibrous structures 10 of the present disclosure.

 Fibrous structures of the present disclosure may be air laid and may be selected from the group consisting of thermal bonded air laid (TBAL) fibrous structures, latex bonded air laid (LBAL) fibrous structures and mixed bonded air laid (MBAL) fibrous structures.

 Fibrous structures of the present disclosure may exhibit a substantially uniform density or
25 may exhibit differential density regions; in other words, regions of high density compared to other regions within the patterned fibrous structure. Typically, when a fibrous structure is not pressed against a cylindrical dryer, such as a Yankee dryer, while the fibrous structure is still wet and supported by a through-air-drying fabric or by another fabric or when an air laid fibrous structure is not spot bonded, the fibrous structure typically exhibits a substantially uniform density.
30 Differential density regions may contribute to the softness of the fibrous structures of the present disclosure (especially when compared to conventional wet press). As a particular example, the fibrous structures of the present disclosure may comprise knuckles and pillows, which can contribute to softness. Softness may be further enhanced when pillows are disposed on a consumer-

facing surface of the fibrous structure, such as a consumer-facing surface of a sanitary tissue product.

As shown in FIGS. 4A, C, and E, fibrous structures of the present disclosure may comprise knuckles 20 and pillows 22, which is one way of achieving differential density. FIG. 5 shows a portion of the pattern on the mask 14 used to make a papermaking belt (not particularly shown, but of the type shown in FIG. 17) that is capable of making the sanitary tissue 12 shown in FIG. 3A. The sanitary tissue 12 of FIG. 3A exhibits a pattern of knuckles 20 and pillows 22 that were formed by discrete cured resin knuckles 20 on a papermaking belt, and which correspond to the white areas, *i.e.*, the cells 24, of the mask 14 shown in FIG. 5.

As depicted in the exemplary fibrous structure shown in FIG. 3A, and more clearly depicted through the masks shown in FIG. 5, the fibrous structures of the present disclosure may have a pattern of discrete knuckles and a continuous/substantially continuous pillow region. However, in other examples the fibrous structures may also have a pattern of discrete pillows and a continuous/substantially continuous knuckle regions.

As shown in FIGS. 4A-F, the fibrous structure may have first and second consumer-facing sides 50. It may be desirable that pillow regions face outwardly, indicated by directional arrow 51, such that the user of the fibrous structure feels the pillows with their skin. It should be understood, that depending on the type of process used to make the fibrous structure, for multi-ply fibrous structures, the consumer-facing side may be the either fabric-side-out (“FSO”) or wire-side-out (WSO). For typical TAD, such as illustrated in FIG. 6A, “fabric side” means the side that touches the TAD fabric (164) and “wire side” means the side that touches the forming wire/forming fabric (154); for UCTAD, such as illustrated in FIG. 6B, “sides” are determined in the TAD section, where the “fabric” side touches the TAD fabric (164) and the “air” side does not. For a process like the one illustrated by FIG. 6A, the relevance of whether the consumer-facing side of the fibrous structure is wire side (WSO) or is fabric side (FSO) is whether a flatter surface (non-pillow-facing-outward surface) is desired, or whether a pillow-facing-outward surface is desired. When pillows face outwardly, TS7 values decrease (versus when knuckles are on the consumer-facing surface).

The fibrous structures of the present disclosure may be pattern densified. A pattern densified fibrous structure is characterized by having a relatively high-bulk field of relatively low fiber density and an array of densified zones (regions) of relatively high fiber density. The high-bulk field is alternatively characterized as a field of pillow zones (regions). The densified zones (regions) are alternatively referred to as knuckle zones (regions). The densified zones (regions)

may be discretely spaced within the high-bulk field or may be interconnected, either fully or partially, within the high-bulk field.

The fibrous structures of the present disclosure may be uncompacted, non-pattern-densified. The fibrous structure may be of a homogenous or multi-layered construction. The fibrous structure may be made with a fibrous furnish that produces a single layer embryonic fibrous web or a fibrous furnish that produces a multi-layer embryonic fibrous web.

The fibrous structures of the present disclosure may comprise any suitable ingredients known in the art. Nonlimiting examples of suitable ingredients that may be included in the fibrous structures include permanent and/or temporary wet strength resins, dry strength resins (e.g., Carboxy Methyl Cellulose (CMC)), softening agents, wetting agents, lint resisting agents, absorbency-enhancing agents, immobilizing agents, especially in combination with emollient lotion compositions, antiviral agents including organic acids, antibacterial agents, polyol polyesters, antimigration agents, polyhydroxy plasticizers, opacifying agents, bonding agents, debonding agents, colorants, and mixtures thereof. Such ingredients, when present in the fibrous structure of the present disclosure, may be present at any level based on the dry weight of the fibrous structure. Such ingredients, when present, may be present at a level of from about 0.001 to about 50%, and/or from about 0.001 to about 20%, and/or from about 0.01 to about 5%, and/or from about 0.03 to about 3%, and/or from about 0.1 to about 1.0% by weight, on a dry fibrous structure basis. It may be desirable to use one or a combination of said suitable ingredients on a fibrous structure comprising short fibers, such as, for example, certain lotion(s) on a fibrous structures comprising eucalyptus and/or bagasse and/or other short fibers.

Fibers

As used herein the term “wood fiber(s)” or “wood content” means fibers derived from both deciduous trees (hereinafter, also referred to as “hardwood”) and coniferous trees (hereinafter, also referred to as “softwood”) may be utilized. Wood fibers may be short (typical of hardwood fibers) or long (typical of softwood fibers). Nonlimiting examples of short fibers useful for the present disclosure include fibers derived from a fiber source selected from the group consisting of Acacia, Eucalyptus, Maple, Oak, Aspen, Birch, Cottonwood, Alder, Ash, Cherry, Elm, Hickory, Poplar, Gum, Walnut, Locust, Sycamore, Beech, Catalpa, Sassafras, Gmelina, Albizia, Anthocephalus, Magnolia, bagasse, wheat straw, certain recycled fiber blends, seaweed, CS10, Lamb’s Ear Trichome fibers. Nonlimiting examples of long fibers include fibers derived from Pine, Spruce, Fir, Tamarack, Hemlock, Cypress, and Cedar

As used herein the term “synthetic fiber(s)” or “synthetic content” means fibers human-made fibers, and specifically excludes “wood fibers” and “non-wood fibers.” Synthetic fibers can be used, in combination with non-wood fibers (e.g., bamboo) in the fibrous structures of the present disclosure. Synthetic fibers may be polymeric fibers. Synthetic fibers may comprise elastomeric polymers, polypropylene, polyethylene, polyester, polyolefin, polyvinyl alcohol and nylon, which are obtained from petroleum sources. Additionally, synthetic fibers may be polymeric fibers comprising natural polymers, which are obtained from natural sources, such as starch sources, protein sources and/or cellulose sources may be used in the fibrous structures of the present disclosure. The synthetic fibers may be produced by any suitable methods known in the art.

As used herein the term “non-wood fiber(s)” or “non-wood content” means naturally-occurring fibers derived from non-wood plants, including animal fibers, mineral fibers, plant fibers and mixtures thereof, and specifically excluding non-naturally-occurring fibers (e.g., synthetic fibers). Animal fibers may, for example, be selected from the group consisting of: wool, silk and other naturally-occurring protein fibers and mixtures thereof. The plant fibers may, for example, be obtained directly from a plant. Nonlimiting examples of suitable plants include cotton, cotton linters, flax, sisal, abaca, hemp, hesperaloe, jute, bamboo, bagasse, kudzu, corn, sorghum, gourd, agave, loofah, trichomes, seed-hairs, wheat, and mixtures thereof.

Non-wood fibers of the present disclosure may be derived from one or more non-wood plants of the family Asparagaceae. Suitable non-wood plants may include, but are limited to, one or more plants of the genus *Agave* such as *A. tequilana*, *A. sisalana* and *A. fourcroyde*, and one or more plants of the genus *Hesperaloe* such as *H. funifera*, *H. parviflora*, *H. nocturna*, *H. Changi*, *H. tenuifolia*, *H. engelmannii*, and *H. malacophylla*. Further, the non-wood fibers of the present disclosure may be prepared from one or more plants of the of the genus *Hesperaloe* such as *H. funifera*, *H. parviflora*, *H. nocturna*, *H. changii*, *H. tenuifolia*, *H. engelmannii*, and *H. malacophylla*.

Fibrous structure(s), web(s) that form the fibrous structure(s), layer(s) of a fibrous structure(s) (including at least one of or each of a first and a second layer of a ply), and/or sheet(s) of a fibrous structure may comprise at least about 5%, about 10%, about 15%, about 20%, about 30%, about 35% about 40%, about 50%, about 75%, about 80%, or about 100% short fiber content, or from about 5% to about 15%, from about 10% to about 30%, from about 20% to about 40%, from about 30% to about 50%, from about 40% to about 60%, from about 50% to about 70%, from about 55% to about 95%, from about 65% to about 85%, from about 60% to about 80%, from about 70% to about 90%, from about 80% to about 100%, from about 90% to about 100%, from about

95% to about 100%, or from about 97.5% to about 100% short fiber content (e.g., eucalyptus, bagasse, etc.), specifically reciting all 0.1% increments within the above-recited ranges of this paragraph and all ranges formed therein or thereby.

5 Bagasse

Generally, the “bagasse,” “bagasse fibers,” “bagasse content,” or “bagasse fiber content” incorporated into fibrous structure(s) of the present disclosure may be made up of “sugar cane bagasse” – the dry pulpy residue left after the extraction of juice from sugar cane or sorghum stalks to extract their juice. Agave bagasse is similar, but is the material remnants after extracting
10 blue agave sap.

Fibrous structure(s), web(s) that form the fibrous structure(s), layer(s) of a fibrous structure(s) (including at least one of or each of a first and a second layer of a ply), and/or sheet(s) of a fibrous structure may comprise at least about 5%, about 10%, about 15%, about 20%, about 30%. About 40%, about 50%, about 75%, about 80%, or about 100% bagasse content, or from
15 about 5% to about 15%, from about 10% to about 30%, from about 20% to about 40%, from about 30% to about 50%, from about 40% to about 60%, from about 50% to about 70%, from about 60% to about 80%, from about 70% to about 90%, from about 80% to about 100%, from about 90% to about 100%, from about 95% to about 100%, or from about 97.5% to about 100% bagasse content, specifically reciting all 0.1% increments within the above-recited ranges of this paragraph and all
20 ranges formed therein or thereby.

Morphology

Short fiber morphology creates challenges that need to be overcome in order to create premium sanitary tissue products. Because short fiber pulps can have low fiber lengths, parenchyma cells, and vessel elements in them, it can be difficult to create high bulk substrates via
25 differential molding. Excess amounts of water being removed at wet transfer, coupled with belt features that are similar in size to the fiber length, means that it can be very difficult to remove the nascent sheet from the structuring belt for further processing.

30 Layers

As shown in FIGS. 4A-4F, and as described in FIGS. 18-1 through 18-5, a ply of fibrous structures of the present disclosure may be homogeneous or may be layered. If layered, a ply of

the fibrous structures may comprise at least two, at least three, least four, and/or at least five layers. The fibrous structures may comprise a single ply, or two, three plies, four, or five plies.

As used herein, the term “layer” means a plurality of strata of fibers, chemical treatments, or the like, within a ply. As used herein, the terms “layered,” “multi-layered,” and the like, refer to
5 fibrous sheets prepared from two or more layers of aqueous papermaking furnish which may be comprised of different fiber types. The layers may be formed from the deposition of separate streams of dilute fiber slurries, upon one or more endless foraminous screens. If the individual layers are initially formed on separate foraminous screens, the layers may be subsequently combined (while wet) to form a layered composite web. Naturally-occurring (e.g., wood and
10 certain non-woods) and/or non-naturally (e.g., synthetic) occurring fibers can also be present in the fibrous structures, as will be disclosed in greater detail below. FIG. 4A illustrates a first ply 53 and a second ply 53 of a fibrous structure 10. Each of the plies may comprise 2 layers 55. The plies may be joined together 57 via adhesive, an emboss, or the like. The pillows 22 may face outwardly 51 toward the consumer-facing side 50 of the fibrous structure 10. Knuckles 20 may face inwardly
15 toward the product-facing side 52 of the fibrous structure 10, which is more commonly associated with process and equipment such as disclosed in FIG. 6A. As illustrated in FIG. 4A, both plies 53 are FSO. FIG. 4B is similar to FIG. 4A, except that the fibrous structure 10 does not have distinct knuckle 20 and pillow 22 regions or zones, which is more commonly associated with process and equipment such as disclosed in FIGS. 6A and 6B. FIGS. 4B and 4C are much like FIGS. 4A and
20 4B, respectively, except that each ply comprises 3 layers 55. FIG. 4E illustrates a single ply comprising 3 layers and is representative of a fibrous structure resulting from process and equipment such as disclosed in FIGS. 6B and 6C; as such, the fibrous structure 10 does not have distinct knuckle 20 and pillow 22 regions or zones. FIG. 4F is like FIG. 4A, except that it comprises 3 plies and, ply 53''' is FSO and has outwardly-facing 51 pillows 22, while ply 53 is WSO and has
25 outwardly-facing 51 knuckles. FIG. 4F may, alternatively, have both plies 53 and 53''' FSO or both plies WSO; and both plies 53 and 53''' may have outwardly-facing 51 pillows 22 or both plies may have outwardly-facing 51 knuckles 20 - these FSO/WSO alternatives and pillow/knuckle alternatives are also true for FIG. 4A and 4C.

It may be desirable to dispose the highest fiber count (million fibers/g) in a most consumer-
30 facing layer of a ply comprising short fibers. A higher fiber count (versus other layer(s) in a ply) may be done in combination with outwardly facing pillows of a consumer-facing side of a fibrous structure of a sanitary tissue product. The outwardly-facing pillow region of a layer (e.g., 55a) may comprise a higher fiber count than an adjacent region of an adjacent layer (e.g., 55b). Further, a

pillow may have a greater basis weight than an adjacent knuckle. Alternatively, a knuckle may have a greater basis weight than an adjacent pillow.

PROPERTIES OF FIBROUS STRUCTURE(S)

5 Fibrous structure(s), web(s) that form the fibrous structure(s), layer(s) of a fibrous structure(s) (including at least one of or each of a first and a second layer of a ply), and/or sheet(s) of a fibrous structure(s) as disclosed herein, particularly including various inventive short fiber inclusions, even including greater than 70% short fibers by weight of the fibrous structure, and greater than 80% short fibers by weight of the fibrous structure, and even including 100% short
10 fibers by weight of the fibrous structure, may have one or a combination of the following properties:

 a CD tear of greater than about 4 gf, or greater than about 6 gf, or greater than about 9 gf, or greater than about 12 gf, or greater than about 15 gf, or greater than about 20 gf, or greater than about 25 gf, about 4 gf to about 30 gf, from about 6 gf to about 28 gf, from about 8 gf to about 26
15 gf, from about 9 gf to about 18 gf, from about 12 gf to about 22 gf, from about 14 gf to about 18 gf, specifically reciting all increments of 0.1 gf within the above-recited ranges and all ranges formed therein or thereby;

 an MD tear of greater than about 7 gf, or greater than about 8 gf, or greater than about 10 gf, or greater than about 12 gf, or greater than about 15 gf, or greater than about 20 gf, or greater than about 22 gf, about 4 gf to about 22 gf, from about 6 gf to about 20 gf, from about 8 gf to about 18 gf, from about 10 gf to about 16 gf, from about 12 gf to about 14 gf, specifically reciting all
20 increments of 0.1 gf within the above-recited ranges and all ranges formed therein or thereby;

 a GM tear of greater than about 6 gf, or greater than about 8 gf, or greater than about 10 gf, or greater than about 12 gf, or greater than about 15 gf, or greater than about 20 gf, about 6 gf to about 20 gf, from about 8 gf to about 18 gf, from about 10 gf to about 16 gf, from about 12 gf to about 14 gf, specifically reciting all increments of 0.1 gf within the above-recited ranges and all
25 ranges formed therein or thereby;

 an HFS of greater than about 13 g/g, or greater than about 14 g/g, or greater than about 15 g/g, or greater than about 16 g/g, or greater than about 16.5 g/g, or greater than about 17 g/g, or greater than about 17.5 g/g, or greater than about 18 g/g, or greater than about 18.5 g/g or greater than about 19 g/g, or greater than about 20 g/g, or greater than about 21 g/g, or from about 4 g/g to about 30 g/g, from about 6 g/g to about 28 g/g, from about 8 g/g to about 26 g/g, from about 10 g/g to about 24 g/g, from about 12 g/g to about 22 g/g, from about 13 g/g to about 20, from about 14
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g/g to about 18 g/g, from about 13 g/g to about 15 g/g, or from about 13 g/g to about 14 g/g, specifically reciting all increments of 0.1 g/g within the above-recited ranges and all ranges formed therein or thereby;

a stack compressibility of greater than about 14 mils/(log(g/in²)), greater than about 18 mils/(log(g/in²)), greater than about 25 mils/(log(g/in²)), 40 mils/(log(g/in²)), greater than about 30 mils/(log(g/in²)), greater than about 35 mils/(log(g/in²)), greater than about 41 mils/(log(g/in²)), greater than about 45 mils/(log(g/in²)), greater than about 50 mils/(log(g/in²)), from about 25 mils/(log(g/in²)) to about 100 mils/(log(g/in²)), from about 30 mils/(log(g/in²)) to about 75 mils/(log(g/in²)), from about 40 mils/(log(g/in²)) to about 50 mils/(log(g/in²)), from about 41 mils/(log(g/in²)) to about 48, or from about 14 mils/(log(g/in²)) to about 36 mils/(log(g/in²)), specifically reciting all increments of 0.1 mils/(log(g/in²)) within the above-recited ranges and all ranges formed therein or thereby;

an MD wet peak elongation of greater than about 6%, greater than about 10%, greater than about 15%, greater than about 18%, greater than about 20%, from about 10% to about 30%, from about 6% to about 22.5%, from about 14% to about 25%, from about 18% to about 22%, or from about 18% to about 20%, specifically reciting all increments of 0.1% within the above-recited ranges and all ranges formed therein or thereby;

a CD wet peak elongation of greater than about 3%, greater than about 5%, greater than about 8%, greater than about 12%, from about 3% to about 17%, from about 5% to about 30%, from about 10% to about 25%, from about 12% to about 20%, or from about 12% to about 15%, specifically reciting all increments of 0.1% within the above-recited ranges and all ranges formed therein or thereby;

an MD wet peak TEA of greater than about 0.8 g*in/in², greater than about 1 g*in/in², greater than about 1.5 g*in/in², greater than about 21 g*in/in², greater than about 22 g*in/in², from about 15 g*in/in² to about 50 g*in/in², from about 20 g*in/in² to about 40 g*in/in², from about 21 g*in/in² to about 30 g*in/in², from about 0.8 g*in/in² to about 2 g*in/in², or from about 21 g*in/in² to about 25 g*in/in², specifically reciting all increments of 1 g*in/in² within the above-recited ranges and all ranges formed therein or thereby; a CD wet peak TEA of greater than about 0.4 g*in/in², greater than about 1 g*in/in², greater than about 1.5 g*in/in², greater than about 2 g*in/in², greater than about 2.5 g*in/in², greater than about 7 g*in/in², from about 0.4 g*in/in² to about 2.8 g*in/in², from about 0.4 g*in/in² to about 3 g*in/in², from about 6 g*in/in² to about 40 g*in/in², from about 6.5 g*in/in² to about 30 g*in/in², from about 7 g*in/in² to about 20 g*in/in², or from about 7.5 g*in/in² to about 15 g*in/in², or from about 8 g*in/in² to about 12 g*in/in², specifically

reciting all increments of 0.5 g*in/in² within the above-recited ranges and all ranges formed therein or thereby;

a CD elongation (dry) of greater than about 5%, of greater than about 8%, of greater than about 12%, of greater than about 13.5%, or from about 5% to about 25%, from about 6% to about 16%, from about 10% to about 20%, from about 12 % to about 18%, from about 13% to about 17%, or from about 14% to about 16%, specifically reciting all increments of 0.5% within the above-recited ranges and all ranges formed therein or thereby;

a CD TEA of greater than about 6 in-g/in², of greater than about 10 in-g/in², of greater than about 15 in-g/in², of greater than about 20 in-g/in², of greater than about 35 in-g/in², of greater than about 32 in-g/in², or from about 6 in-g/in² to about 22 in-g/in², from about 5 in-g/in² to about 100 in-g/in², from about 15 in-g/in² to about 75 in-g/in², from about 25 in-g/in² to about 50 in-g/in², from about 32 in-g/in² to about 45 in-g/in², from about 33 in-g/in² to about 40 in-g/in², from about 34 in-g/in² to about 38 in-g/in², specifically reciting all increments of 1 in-g/in² within the above-recited ranges and all ranges formed therein or thereby;

a dry CD tensile modulus / dry CD tensile peak load (derived from the appropriate of: 1) Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Toilet Paper, 2) Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Paper Towels, or 3) Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Facial Tissue) less than about 5.0 g/g, less than about 4.5 g/g, less than about 4.0 g/g, less than about 3.5 g/g, less than about 3.0 g/g, from about 5.0 g/g to about 2.5 g/g, from about 4.0 g/g to about 2.0 g/g, or from about 3.5 g/g to about 1.5 g/g, specifically reciting all increments of 0.1 g/g within the above-recited ranges and all ranges formed therein or thereby;

a wet CD tensile modulus / wet CD tensile peak load less than about 5.0 g/g, less than about 4.5 g/g, less than about 4.25 g/g, less than about 4.0 g/g, less than about 3.75 g/g, less than about 3.5 g/g, less than about 3.25 g/g, less than about 3.0 g/g, less than about 2.5 g/g, less than about 2 g/g, from about 5.0 g/g to about 2.5 g/g, from about 4.0 g/g to about 2.0 g/g, or from about 3.5 g/g to about 1.5 g/g, specifically reciting all increments of 0.1 g/g within the above-recited ranges and all ranges formed therein or thereby;

a CD modulus (dry) of less than about 2000 g/cm, of less than about 2400 g/cm, of less than about 2500 g/cm, of less than about 3270 g/cm, or from about 200 g/cm to about 5000 g/cm, or from about 637 g/cm to about 1618 g/cm, or from about 650 g/cm to about 1600 g/cm, or from about 750 g/cm to about 1200 g/cm, or from about 1000 g/cm to about 4500 g/cm, or from about 2000 g/cm to about 4000 g/cm, or from about 3000 g/cm to about 4000 g/cm, or from about 3270

g/cm to about 3800 g/cm, or from about 3300 g/cm to about 3700 g/cm, or from about 3350 g/cm to about 3600 g/cm, or from about 3400 g/cm to about 3500 g/cm, specifically reciting all increments of 1 g/cm within the above-recited ranges and all ranges formed therein or thereby;

an MD modulus (dry) of less than about 3360 g/cm, or less than about 1750 g/cm, or from
5 about 500 g/cm to about 6000 g/cm, or from about 500 g/cm to about 1000 g/cm, or from about 526 g/cm to about 1008 g/cm, or from about 600 g/cm to about 750 g/cm, or from about 1000 g/cm to about 5000 g/cm, or from about 2000 g/cm to about 4000 g/cm, or from about 3000 g/cm to about 4000 g/cm, or from about 3360 g/cm to about 3800 g/cm, or from about 3400 g/cm to about 3700 g/cm, or from about 3450 g/cm to about 3600 g/cm, or from about 3500 g/cm to about 3600
10 g/cm, specifically reciting all increments of 1 g/cm within the above-recited ranges and all ranges formed therein or thereby;

a TS7 of less than about 40.00 dB V² rms, or less than about 30.00 dB V² rms, or less than about 22.00 dB V² rms, or less than about 20.00 dB V² rms, or less than about 24.00 dB V² rms, or less than about 15.00 dB V² rms, or less than about 14.00 dB V² rms, or less than about 10.00 dB
15 V² rms, or less than about 8.00 dB V² rms, or greater than about 5.00 dB V² rms, or between about 3.00 dB V² rms and about 40.00 dB V² rms (“between about ‘X’ and about ‘X’” is used interchangeably with “from about ‘X’ to about ‘X’”), or between about 3.00 dB V² rms and about 20.00 dB V² rms, or between about 4.00 dB V² rms and about 30 dB V² rms, or between about 7.6 dB V² rms and about 11.00 dB V² rms, or between about 15.00 dB V² rms and about 30.00 dB V²
20 rms, or between about 5.00 dB V² rms and about 20.00 dB V² rms, or between about 6.00 dB V² rms and about 14 dB V² rms, or between about 7.00 dB V² rms and about 12.00 dB V² rms, or between about 8.00 dB V² rms and about 11.50 dB V² rms, or between about 9.0 dB V² rms and about 11.00 dB V² rms, or between about 9.50 dB V² rms and about 10.50 dB V² rms, between about 9.50 dB V² rms and about 10.00 dB V² rms, between about 15 dB V² rms and about 17 dB
25 V² rms, or between about 15 dB V² rms and about 16 dB V² rms, specifically reciting all increments of 0.01 dB V² rms within the above-recited ranges and all ranges formed therein or thereby;

a compressive slope (Dry-1500) of less than about 14.0 mil/g, or less than about 3.0 mil/g, or less than about 4.0 mil/g, or less than about 5.0 mil/g, or less than about 6.0 mil/g, or less than about 7.0 mil/g, or less than about 8.0 mil/g, or less than about 9.0 mil/g, or greater than about 12.0
30 mil/g 8, or greater than about 11.0 mil/g, or greater than about 12.0 mil/g, or between about 4.0 mil/g and about 10.0 mil/g, or between about 8.0 mil/g and about 12.0 mil/g, or between about 6 mil/g and about 14.0 mil/g, or between about 5 mil/g and about 8.7 mil/g, or between about 8.0 mil/g and about 14 mil/g, or between about 7.5 mil/g and about 11 mil/g, or between about 12.0

mil/g and about 3.0 mil/g, or between about 11.0 mil/g and about 5.0 mil/g, or between about 10.0 mil/g and about 4.0 mil/g, or between about 8.0 mil/g and about 5.0 mil/g, specifically reciting all increments of 0.01 mil/g within the above-recited ranges and all ranges formed therein or thereby;

a compressive slope (Dry-200) of less than about 10.0 mil/g, or less than about 9.0 mil/g,
5 or less than about 8.0 mil/g, or less than about 3.0 mil/g, or less than about 4.0 mil/g, or less than about 5.0 mil/g, or less than about 6.0 mil/g, or less than about 7.0 mil/g, or less than about 8.0 mil/g, or less than about 9.0 mil/g, or greater than about 12.0 mil/g, or greater than about 11.0 mil/g, or greater than about 12.0 mil/g, or between about 6.3 mil/g and about 8.5 mil/g, or between about 8.0 mil/g and about 12.0 mil/g, or between about 6 mil/g and about 14.0 mil/g, or between
10 about 5 mil/g and about 8.7 mil/g, or between about 8.0 mil/g and about 14 mil/g, or between about 7.5 mil/g and about 11 mil/g, or between about 12.0 mil/g and about 3.0 mil/g, or between about 11.0 mil/g and about 5.0 mil/g, or between about 10.0 mil/g and about 4.0 mil/g, or between about 8.0 mil/g and about 5.0 mil/g, specifically reciting all increments of 0.01 mil/g within the above-recited ranges and all ranges formed therein or thereby;

a formation index of less than about 170, or less than about 90, or less than about 65, or
15 greater than about 30, or greater than about 50, or between about 55 and about 165, or between about 55 and about 85, or between about 60 and about 80, or between about 65 and about 75, specifically reciting all increments of 0.1 within the above-recited ranges and all ranges formed therein or thereby; a coverage of less than about 10 fiber layers (making up a layer 55 of a ply 53),
20 or less than about 9 fiber layers, or less than about 8 fiber layers, or less than about 7 fiber layers, or less than about 6 fiber layers, or less than about 5 fiber layers, or less than about 4 fiber layers, or greater than about 2 fiber layers, or greater than about 4.75 fiber layers, or greater than about 5 fiber layers, or greater than about 5.25 fiber layers, or greater than about 5.5 fiber layers, or greater than about 5.75 fiber layers, or greater than about 6 fiber layers, or greater than about 6.25 fiber
25 layers, or greater than about 6.5 fiber layers, or greater than about 7 fiber layers, or greater than about 7.25 fiber layers, or greater than about 7.5 fiber layers, or greater than about 7.75 fiber layers, or greater than about 8 fiber layers, or greater than about 8.25 fiber layers, or greater than about 8.5 fiber layers, or greater than about 9 fiber layers, or between about 2 and about 10 fiber layers, or between about 4 and about fiber 9 fiber layers, or between about 5 and about fiber 8 fiber
30 layers, or between about 4 and about fiber 7 fiber layers, specifically reciting all increments of 1 fiber layer within the above-recited ranges and all ranges formed therein or thereby;

a coarseness (according to the Coverage and Fiber Count Test Method) of less than about 0.35 mg/m, or less than about 0.30 mg/m, or less than about 0.25 mg/m, or less than about 0.20

mg/m, or greater than about 0.13 mg/m, or greater than about 0.14 mg/m, or greater than about 0.15 mg/m, or greater than about 0.16 mg/m, or greater than about 0.17 mg/m, or between about 0.15 mg/m and about 0.35 mg/m, or between about 0.15 mg/m and about 0.30 mg/m, or between about 0.16 mg/m and about 1.7 mg/m, or between about 0.15 mg/m and about 0.17 mg/m, or
5 between about 0.15 mg/m and about 0.20 mg/m, or between about 0.25 mg/m and about 0.26 mg/m, or between about 0.22 mg/m and about 0.3 mg/m, or between about 0.19 mg/m and about 0.32 mg/m, specifically reciting all increments of 0.01 mg/m within the above-recited ranges and all ranges formed therein or thereby;

a lint value of less than about 11, or less than about 10, or less than about 9, or less than
10 about 8, or less than about 7, or less than about 6, or less than about 5, or greater than about 0.5, greater than about 4.1, greater than about 6, or between about 0.5 and about 11, or between about 0.7 and about 11, or between about 7.5 and about 10.5, or between about 4 and about 5.5, or between about 6.3 and about 7.7, or between about 3 and about 10, or between about 5 and about 10, or between about 4 and about 9, or between about 5 and about 8, or between about 6 and about
15 8, specifically reciting all increments of 0.01 (Hunter L value) within the above-recited ranges and all ranges formed therein or thereby;

a fiber length of less than about 4 mm, of less than about 3 mm, of less than about 2.3 mm, or less than about 2.2 mm, or less than about 2.1 mm, or less than about 2.0 mm, or less than about 1.9 mm, or less than about 1.5 mm, or less than about 1.4, or greater than about 0.7, or greater than
20 about 1, or greater than about 2 mm or between about 0.6 mm and about 2.4 mm, or between about 0.7 mm and about 2.2 mm, or between about 0.8 mm and about 2 mm, or between 2.5 mm and 3.7 mm, or between about 0.9 mm and about 1.8 mm, or between about 1 mm and about 1.6 mm, or between about 1.1 mm and about 1.5 mm, or between about 1.1 mm and about 1.4 mm, or between about 1.1 mm and about 1.3 mm, specifically reciting all increments of 0.01 mm within the above-
25 recited ranges and all ranges formed therein or thereby;

a weight weighted mean fiber length of less than about 4 mm, of less than about 3 mm, of less than about 2.3 mm, or less than about 2.2 mm, or less than about 2.1 mm, or less than about 2.0 mm, or less than about 1.9 mm, or less than about 1.5 mm, or less than about 1.4, or greater than about 0.7, or greater than about 1, or greater than about 2 mm or between about 0.6 mm and
30 about 2.4 mm, or between about 0.7 mm and about 2.2 mm, or between about 0.8 mm and about 2 mm, or between 2.5 mm and 3.7 mm, or between about 0.9 mm and about 1.8 mm, or between about 0.85 mm and about 1.4 mm, or between about 1 mm and about 1.6 mm, or between about 1.1 mm and about 1.5 mm, or between about 1.1 mm and about 1.4 mm, or between about 1.1 mm

and about 1.3 mm, specifically reciting all increments of 0.01 mm within the above-recited ranges and all ranges formed therein or thereby;

a fiber width of less than about 31 μm , or less than about 28 μm , or less than about 25 μm , or less than about 22 μm , or less than about 20 μm , or greater than about 8 μm , or between about 5 μm and about 32 μm , or between about 8 μm and about 31 μm , or between about 10 μm and about 28 μm , or between about 12 μm and about 26 μm , or between about 14 μm and about 24 μm , or between about 16 μm and about 22 μm , or between about 22 μm and about 27 μm , or between about 25 μm and about 31 μm , or between about 15 μm and about 19 μm , or between about 18 μm and about 20 μm , or between about 7.5 μm and about 9.5 μm , specifically reciting all increments of 0.1 μm within the above-recited ranges and all ranges formed therein or thereby;

a fiber length/width ratio (according to the Fiber Length, Width, Coarseness, and Fiber Count Test Method) of less than about 190, or less than about 180, or less than about 170, or less than about 160, or less than about 150, or less than about 140, or less than about 130, or less than about 120, or less than about 110, or less than about 106, or less than about 100, or less than about 75, or less than about 50, or greater than about 40, or between about 190 and about 35, or between about 185 and about 40, or between about 175 and about 50, or between about 150 and about 75, or between about 125 and about 100, specifically reciting all increments of 1 within the above-recited ranges and all ranges formed therein or thereby;

a fiber count (length average) of less than about 30 fibers/g, or less than about 25 fibers/g, or less than about 20 fibers/g, or less than about 16 fibers/g, or less than about 15 fibers/g, or less than about 14 fibers/g, or less than about 13 fibers/g, or less than about 10 fibers/g, or greater than about 3 fibers/g, or between about 2.75 fibers/g and about 5 fibers/g, or between about 3 fibers/g and about 35 fibers/g, or between about 3.5 fibers/g and about 30 fibers/g, or between about 5 fibers/g and about 25 fibers/g, or between about 10 fibers/g and about 20 fibers/g, or between about 10 fibers/g and about 15 fibers/g, specifically reciting all increments of 0.1 fibers/g within the above-recited ranges and all ranges formed therein or thereby;

a fiber count (number average) of less than about 30 fibers/g, or less than about 25 fibers/g, or less than about 20 fibers/g, or less than about 16 fibers/g, or less than about 15 fibers/g, or less than about 14 fibers/g, or less than about 13 fibers/g, or less than about 10 fibers/g, or greater than about 3 fibers/g, or greater than about 8.9 fibers/g, or between about 3 fibers/g and about 35 fibers/g, or between about 3.5 fibers/g and about 30 fibers/g, or between about 5 fibers/g and about 25 fibers/g, or between about 10 fibers/g and about 20 fibers/g, or between about 10 fibers/g and

about 15 fibers/g, specifically reciting all increments of 0.1 fibers/g within the above-recited ranges and all ranges formed therein or thereby;

fiber count-area (C(n)) of greater than about 800 million/m², greater than about 830 million/m², greater than about 850 million/m², greater than about 900 million/m², greater than
5 about 950 million/m², greater than about 1,000 million/m², or less than about 1,050 million/m², less than about 950 million/m², or from about 800 million/m² to about 1,000 million/m², from about 850 million/m² to about 975 million/m², specifically reciting all increments of 1 million/m² within the above-recited ranges and all ranges formed therein or thereby;

10 fiber count-area (C(l)) of greater than about 260 million/m², greater than about 280 million/m², greater than about 300 million/m², greater than about 350 million/m², greater than about 400 million/m², greater than about 450 million/m², greater than about 500 million/m², greater than about 525 million/m², or less than about 530 million/m², less than about 500 million/m², less than about 400 million/m², or from about 260 million/m² to about 530
15 million/m², from about 260 million/m² to about 400 million/m², from about 260 million/m² to about 400 million/m², specifically reciting all increments of 1 million/m² within the above-recited ranges and all ranges formed therein or thereby;

a tensile ratio (also called "dry tensile ratio," see the Dry Elongation, Tensile Strength, TEA and Modulus Test Methods below) of less than about 4.5, or less than about 4, or less than about
20 3.5, or less than about 3, or less than about 2.5, or less than about 2.1, or less than about 2, or less than about 1.9, or less than about 1.7, or greater than about 0.5, or greater than about 1.3, or greater than about 1.6, or greater than about 2, or greater than about 2.5, or between about 0.4 and about 0.5, or between about 0.5 and about 4.5, or between about 1.1 and about 1.6, or between about 1.25 and about 3, or between about 1.8 and about 2.4, or between about 1 and about 3, or between about
25 1.2 and about 2.1, or between about 1.5 and about 2, or between about 1.7 and about 2, specifically reciting all increments of 0.01 within the above-recited ranges and all ranges formed therein or thereby;

an Emtec TS750 of greater than about 10 dB V² rms, or greater than about 20 dB V² rms, or greater than about 40 dB V² rms, or greater than about 47.7 dB V² rms, or greater than about 50
30 dB V² rms, or greater than about 75 dB V² rms, or less than about 115 dB V² rms, or less than about 20 dB V² rms, or less than about 40 dB V² rms, or less than about 45 dB V² rms, or less than about 60 dB V² rms, or less than about 80 dB V² rms, or between about 10 dB V² rms and about 120 dB V² rms, or between about 14 dB V² rms and about 113 dB V² rms, or between about 14 dB V² rms

and about 75 dB V^2 rms, or between about 27 dB V^2 rms and about 50 dB V^2 rms, or between about 50 dB V^2 rms and about 112 dB V^2 rms, or between about 15 dB V^2 rms and about 50 dB V^2 , or between about 16 dB V^2 rms and about 40 dB V^2 , or between about 20 dB V^2 rms and about 30 dB V^2 , or between about 25 dB V^2 rms and about 35 dB V^2 , or between about 40 dB V^2 rms and about 55 dB V^2 , specifically reciting all increments of 1 dB V^2 rms within the above-recited ranges and all ranges formed therein or thereby;

a slip stick of greater than about 235, or greater than about 270 greater than about 300, or greater than about 350, or greater than about 400, or greater than about 500, or greater than about 600, or greater than about 700, greater than about 800, or greater than about 900, or less than about 435, or less than about 605, or less than about 1000, or between about 230 and about 1400, or between about 235 and about 435, or between about 235 and about 605, or between about 280 and about 965, or between about 300 and about 800, or between about 320 and about 440, or between about 350 and about 500, or between about 400 and about 600, specifically reciting all increments of 10 within the above-recited ranges and all ranges formed therein or thereby;

a density of a first zone (a first region) or a pillow zone may be different than a density of a second zone (a second region or a knuckle zone), which is adjacent to the first zone, such that the density of a second zone (a second region or a knuckle zone) may be 5%, 10%, 15%, 20%, 30%, 40%, 50%, 75%, 100%, 125%, 150%, 175%, or 200% greater than the first zone (first region or pillow zone), specifically reciting all increments of 0.01% within the above-recited ranges and all ranges formed therein or thereby (the Micro-CT Intensive Property Measurement Method can be used to determine density of an area of interest);

a Runkel Ratio of greater than about 1, or greater than about 2, or greater than about 3, or greater than about 5, or greater than about 6, or greater than about 7, or less than about 10, between about 0.5 and about 10, or between about 1 and about 8, or between about 1.5 and about 6.5, specifically reciting all increments of 0.1 within the above-recited ranges and all ranges formed therein or thereby;

a 2.5-160 micron PVD desorption of less than about 1600 mg, or less than about 1550 mg, or less than about 1500 mg, or less than about 1400 mg, or less than about 1300 mg, or less than about 1200 mg, or less than about 1100 mg, or less than about 1000 mg, or less than about 900 mg, or less than about 800 mg, or less than about 700 mg, or less than about 600 mg, or greater than about 550 mg, or between about 550 mg and about 1600 mg, or between about 600 mg and about 1550 mg, or between about 700 mg and about 1550 mg, or between about 825 mg and about 1550 mg, or between about 850 mg and about 1500 mg, or between about 900 mg and about 1400 mg,

or between about 1000 mg and about 1200 mg, specifically reciting all increments of 1 mg within the above-recited ranges and all ranges formed therein or thereby;

a 2.5-160 micron PVD absorption of less than about 1200 mg, or less than about 1100 mg, or less than about 1000 mg, or less than about 900 mg, or greater than about 400 mg, or greater than about 800 mg, or greater than about 825 mg, or between about 400 mg and about 1200 mg, or between about 500 mg and about 1200 mg, or between about 600 mg and about 1200 mg, or between about 700 mg and about 1200 mg, or between about 800 mg and about 1200 mg, or between about 900 mg and about 1100 mg, specifically reciting all increments of 1 mg within the above-recited ranges and all ranges formed therein or thereby; a VFS of greater than about 4 g/g, or greater than about 5.5 g/g, or greater than about 6.0 g/g, or greater than about 7.0 g/g, or greater than about 7.3 g/g, or greater than about 7.5 g/g, or greater than about 8 mg, or greater than about 8.5 g/g, or greater than about 9 g/g, or greater than about 9.5 g/g, or greater than about 10 g/g, or greater than about 10.5 g/g, or greater than about 11 g/g, or greater than about 11.5 g/g, or greater than about 12 g/g, or greater than about 12.5 g/g, or less than about 13 g/g, or between about 4 g/g and about 15 g/g, or between about 5 g/g and about 11 g/g, or between about 10 g/g and about 15 g/g, or between about 7 g/g and about 13 g/g, or between about 7.5 g/g and about 13 g/g, or between about 8 g/g and about 13 g/g, or between about 9 g/g and about 13 g/g, or between about 10 g/g and about 13 g/g, or between about 10.5 g/g and about 12.5 g/g, or between about 10 g/g and about 12 g/g, or between about 10.5 g/g and about 11.5 g/g, reciting all increments of 0.1 g/g within the above-recited ranges and all ranges formed therein or thereby;

a residual water of less than about 10%, less than about 9%, less than about 7%, less than about 5%, less than about 4%, less than about 3.5%, from about 1% to about 20%, from about 2% to about 18%, from about 3% to about 16%, from about 4% to about 14%, from about 5% to about 12%, from about 6% to about 10%, from about 1% to about 3%, or from about 1% to about 2%, specifically reciting all increments of 0.1% within the above-recited ranges and all ranges formed therein or thereby;

a basis weight of at least about 47 g/m² (i.e., gsm), of between about 10 g/m² and about 100 g/m², or between about 10 g/m² and about 45 g/m², between about 20 g/m² and about 40 g/m², or between about 24 g/m² and about 40 g/m², or between about 30 g/m² and about 32 g/m², or between about 40 g/m² and about 65 g/m², or between about 45 g/m² and about 60 g/m², or between about 47 g/m² and about 52 g/m², or between about 50 g/m² and about 58 g/m², or between about 50 g/m² and about 55 g/m², or between about 50 g/m² and about 75 g/m², specifically reciting all increments of 0.1 g/m² within the above-recited ranges and all ranges formed therein or thereby;

a density (based on measuring caliper at 95 g/in²) of less than about 0.60 g/cm³, or less than about 0.30 g/cm³, or less than about 0.20 g/cm³, or less than about 0.10 g/cm³, or less than about 0.07 g/cm³, or less than about 0.05 g/cm³, or from about 0.01 g/cm³ to about 0.20 g/cm³, or from about 0.074 g/cm³ to about 0.087 g/cm³, or from about 0.02 g/cm³ to about 0.10 g/cm³, specifically reciting all increments of 0.001 g/cm³ within the above-recited ranges and all ranges formed therein or thereby;

a bulk (also called “dry bulk,” based on measuring caliper at 95 g/in²) of greater than about 1.67 cm³/g and/or greater than about 3.33 cm³/g and/or greater than about 5.00 cm³/g and/or greater than about 10.00 cm³/g and/or greater than about 14.29 cm³/g and/or greater than about 10.00 cm³/g and/or greater than about 14.29 cm³/g and/or greater than about 15.0 cm³/g and/or greater than about 18.0 cm³/g and/or greater than about 20.00 cm³/g and/or from about 100.00 cm³/g to about 5.00 cm³/g and/or from about 50.00 cm³/g to about 10.00 cm³/g, and/or from about 10.00 cm³/g to about 15.00 cm³/g, and/or from about 11.5 cm³/g to about 13.5 cm³/g, specifically reciting all increments of 0.01 cm³/g within the above-recited ranges and all ranges formed therein or thereby (Note: This is distinct from “Dry Bulk Ratio” and “Resilient Bulk.”);

an SST (absorbency rate) of greater than about 0.3 g/sec^{0.5}, or greater than about 0.4 g/sec^{0.5}, or greater than about 0.45 g/sec^{0.5}, or greater than about 0.5 g/sec^{0.5}, or greater than about 0.75 g/sec^{0.5}, or greater than about 1.0 g/sec^{0.5}, or greater than about 1.60 g/sec^{0.5}, or greater than about 1.65 g/sec^{0.5}, or greater than about 1.70 g/sec^{0.5}, or greater than about 1.75 g/sec^{0.5}, or greater than about 1.80 g/sec^{0.5}, or greater than about 1.82 g/sec^{0.5}, or greater than about 1.85 g/sec^{0.5}, or greater than about 1.88 g/sec^{0.5}, or greater than about 1.90 g/sec^{0.5}, or greater than about 1.95 g/sec^{0.5}, or greater than about 2.00 g/sec^{0.5}, or between about 0.31 g/sec^{0.5} and about 0.65 g/sec^{0.5}, or between about 1.60 g/sec^{0.5} and about 2.50 g/sec^{0.5}, between about 1.0 g/sec^{0.5} and about 2.0 g/sec^{0.5}, or between about 2.0 g/sec^{0.5} and about 2.50 g/sec^{0.5}, or between about 0.3 g/sec^{0.5} and about 0.7 g/sec^{0.5}, or between about 1.0 g/sec^{0.5} and about 1.50 g/sec^{0.5}, or between about 0.3 g/sec^{0.5} and about 0.9 g/sec^{0.5}, or between about 1.65 g/sec^{0.5} and about 2.50 g/sec^{0.5}, or between about 1.70 g/sec^{0.5} and about 2.40 g/sec^{0.5}, or between about 1.75 g/sec^{0.5} and about 2.30 g/sec^{0.5}, or between about 1.80 g/sec^{0.5} and about 2.20 g/sec^{0.5}, or between about 1.82 g/sec^{0.5} and about 2.10 g/sec^{0.5}, or between about 1.85 g/sec^{0.5} and about 2.00 g/sec^{0.5}, specifically reciting all increments of 0.1 g/sec^{0.5} within the above-recited ranges and all ranges formed therein or thereby;

a plate stiffness of greater than about 0.3 N*mm, or greater than about 0.5 N*mm, or greater than about 1.0 N*mm, or greater than about 2.0 N*mm, or greater than about 4.0 N*mm, or greater

than about 6.0 N*mm, or greater than about 8.0 N*mm, or greater than about 12.0 N*mm, or greater than about 12.5 N*mm, or greater than about 13.0 N*mm, or greater than about 13.5 N*mm, or greater than about 14 N*mm, or greater than about 14.5 N*mm, or greater than about 15 N*mm, or greater than about 15.5 N*mm, or greater than about 16 N*mm, or greater than about 16.5 N*mm, or greater than about 17 N*mm, or between about 0.3 N*mm and about 20 N*mm, or between about 1 N*mm and about 20 N*mm, or between about 2 N*mm and about 20 N*mm, or between about 3 N*mm and about 4.75 N*mm, or between about 4 N*mm and about 20 N*mm, or between about 6 N*mm and about 20 N*mm, or between about 8 N*mm and about 20 N*mm, or between about 10 N*mm and about 20 N*mm, or between about 12 N*mm and about 20 N*mm, or between about 12.5 N*mm and about 20 N*mm, or between about 13 N*mm and about 20 N*mm, or between about 13.5 N*mm and about 20 N*mm, or between about 14 N*mm and about 20 N*mm, or between about 14.5 N*mm and about 20 N*mm, or between about 15 N*mm and about 20 N*mm, or between about 15.5 N*mm and about 20 N*mm, or between about 16 N*mm and about 20 N*mm, or between about 16.5 N*mm and about 20 N*mm, or between about 17 N*mm and about 20 N*mm, specifically reciting all increments of 0.1 N*mm within the above-recited ranges and all ranges formed therein or thereby;

a resilient bulk of greater than about 25 cm³/g, or greater than about 29 cm³/g, or greater than about 40 cm³/g, or greater than about 50 cm³/g, or greater than about 60 cm³/g, or greater than about 62 cm³/g, or greater than about 75 cm³/g, or greater than about 85 cm³/g, or greater than about 90 cm³/g, or greater than about 95 cm³/g, or greater than about 100 cm³/g, or greater than about 102 cm³/g, or greater than about 105 cm³/g, or between about 29 cm³/g and about 112 cm³/g, or between about 29 cm³/g and about 103 cm³/g, or between about 40 cm³/g and about 100 cm³/g, or between about 50 cm³/g and about 75 cm³/g, or between about 61 cm³/g and about 87 cm³/g, or between about 55 cm³/g and 70 cm³/g, or between about 85 cm³/g and about 110 cm³/g, or between about 90 cm³/g and about 110 cm³/g, or between about 95 cm³/g and about 110 cm³/g, or between about 100 cm³/g and about 110 cm³/g, specifically reciting all increments of 1 cm³/g within the above-recited ranges and all ranges formed therein or thereby;

a total wet tensile of greater than about 50 g/in, or greater than about 75 g/in, or greater than about 100 g/in, or greater than about 200 g/in, or greater than about 300 g/in, or greater than about 400 g/in, or greater than about 450 g/in, or greater than about 470 g/in, or greater than about 500 g/in, or greater than about 550 g/in, or greater than about 600 g/in, or greater than about 650 g/in, or greater than about 700 g/in, or greater than about 750 g/in, or greater than about 758 g/in, or greater than about 800 g/in, or greater than about 850 g/in, or greater than about 900 g/in, or

greater than about 2278, or between about 350 g/in and about 475 g/in, or between about 420 g/in and about 440 g/in, or between about 100 g/in and about 640 g/in, or between about 300 g/in and about 1000 g/in, or between about 400 g/in and about 900 g/in, or between about 500 g/in and about 900 g/in, or between about 550 g/in and about 900 g/in, or between about 600 g/in and about 900 g/in, or between about 650 g/in and about 900 g/in, or between about 700 g/in and about 900 g/in, specifically reciting all increments of 10 g/in within the above-recited ranges and all ranges formed therein or thereby;

5 a total wet tensile (Finch) of greater than about 10 g/in and about 125 g/in, or between about 16 g/in and about 65 g/in, or between about 20 g/in and about 55 g/in, or between about 30 g/in and about 100 g/in, or between about 10 g/in and about 65 g/in, specifically reciting all increments of 1 g/in within the above-recited ranges and all ranges formed therein or thereby;

10 a dry burst (peak load) strength of greater than about 250 g, or greater than about 400 g, or greater than about 600 g, or greater than about 800 g, or greater than about 1000 g, or greater than about 1200 g, or greater than about 1300 g, or greater than about 1400 g, or between about 250 g and about 1500 g, or between about 400 g and about 1500 g, or between about 600 g and about 1500 g, or between about 800 g and about 1450 g, or between about 1000 g and about 1400 g;

15 a wet burst (peak load) strength of greater than about 3 g, greater than about 5 g, or greater than about 10 g, or greater than about 20 g, or greater than about 50 g, or greater than about 55 g, or greater than about 75 g, or greater than about 100 g, or greater than about 115 g, or greater than about 150 g, or greater than about 177 g, or greater than about 200 g, or greater than about 300 g, or greater than about 350 g, or greater than about 400 g, or greater than about 450 g, or greater than about 478 g, or greater than about 500 g, or greater than about 550 g, or greater than about 600 g, or between about 20 g and about 530 g, or between about 3 g and about 22 g, or between about 9 g and about 40 g, or between about 25 g and about 52 g, or between about 230 g and about 525 g, or between about 180 g and about 525 g, or between about 200 g and about 700 g, or between about 350 g and about 600 g, or between about 350 g and about 550 g, or between about 400 g and about 550 g, or between about 400 g and about 525 g, or between about 50 g and about 220 g, or between about 50 g and about 60 g, or between about 50 g and 55 g, specifically reciting all increments of 10 g within the above-recited ranges and all ranges formed therein or thereby;

25 a flexural rigidity (avg.) of greater than about 40 mg-cm, greater than about 75 mg-cm, greater than about 175 mg-cm, 100, greater than about 125 mg-cm, greater than about 150 mg-cm, greater than about 175 mg-cm, greater than about 200 mg-cm, or greater than about 700 mg-cm, or greater than about 800 mg-cm, or greater than about 900 mg-cm, or greater than about 1000 mg-

cm, or greater than about 1100 mg-cm, or greater than about 1200 mg-cm, or greater than about 1300 mg-cm, or greater than about 1400 mg-cm, or greater than about 1500 mg-cm, or greater than about 1600 mg-cm, or greater than about 1700 mg-cm, or between about 40 mg-cm and about 200 mg-cm, or between about 60 mg-cm and about 150 mg-cm, or between about 80 mg-cm and about 125 mg-cm, or between about 80 mg-cm and about 100 mg-cm, or between about 132 mg-cm and about 232 mg-cm, or between about 700 mg-cm and about 1800 mg-cm, or between about 800 mg-cm and about 1600 mg-cm, or between about 900 mg-cm and about 1400 mg-cm, or between about 1000 mg-cm and about 1350 mg-cm, or between about 1050 mg-cm and about 1350 mg-cm, or between about 1100 mg-cm and about 1350 mg-cm, or between about 1100 mg-cm and about 1300 mg-cm, specifically reciting all increments of 10 mg-cm within the above-recited ranges and all ranges formed therein or thereby;

a dry caliper of greater than about 4.0 mils, or greater than about 10.0 mils, or greater than about 15.0 mils, or greater than about 20.0 mils, or than about 26.0 mils, or than about 28.0 mils, or greater than about 40 mils, or greater than about 55 mils, or between about 4.0 mils and about 27.0 mils, or between about 18.0 mils and about 24.0 mils, or between about 45.0 mils and about 51.0 mils, or between about 29 mils and about 33.0 mils, or between about 19.0 mils and about 43.0 mils, or between about 23.0 mils and about 26.0 mils, or between about 26.0 mils and about 80.0 mils, or between 40.0 mils and 60.0 mils, or between about 50 and about 60 mils, specifically reciting all increments of 0.10 mils within the above-recited ranges and all ranges formed therein or thereby;

a wet caliper of greater than about 8.0 mils, or greater than about 10.0 mils, or greater than about 15.0 mils, or greater than about 17.0 mils, or greater than about 26 mils, or between about 10.0 mils and about 33.0 mils, or between about 15.0 mils and about 25.0 mils, or between about 8.0 mils and about 20.0 mils, or between about 26.0 mils and about 70.0 mils, or between about 26.0 mils and about 40.0 mils, specifically reciting all increments of 0.10 mils within the above-recited ranges and all ranges formed therein or thereby; a total dry tensile (total tensile) of greater than about 250 g/in, or greater than about 400 g/in, or greater than about 500 g/in, or greater than about 700 g/in, or greater than about 800 g/in, or greater than about 1000 g/in, or greater than about 1200 g/in, or greater than about 1300 g/in, or greater than about 1700 g/in, or greater than about 2278 g/in, or between about 880 g/in and about 2570 g/in, or between about 1800 g/in and about 2485 g/in, or between about 1900 g/in and about 2300 g/in, or between about 250 g/in and about 1000 g/in, or between about 440 g/in and about 635 g/in, or between about 400 g/in and about 580 g/in, or between about 700 g/in and about 800 g/in, or between about 275 g/in and about 1310 g/in,

or about 1300 g/in and about 4000 g/in, or between about 1800 g/in and about 2800 g/in, specifically reciting all increments of 10 g/in within the above-recited ranges and all ranges formed therein or thereby;

a geometric mean (GM) dry modulus of greater than about 500 g/cm, greater than about 1000 g/cm, or greater than about 1700 g/cm, or less than about 3320 g/cm, or less than about 2500 g/cm, or less than about 2400 g/cm, or less than about 2300 g/cm, or less than about 2000 g/cm, or less than about 1500 g/cm, or less than about 1000 g/cm, or between about 578 g/cm and about 1266 g/cm, or between about 1800 g/cm and about 4000 g/cm, or between about 1800 g/cm and about 3500 g/cm, or between about 3300 g/cm and about 3350 g/cm, specifically reciting all increments of 10 g/cm within the above-recited ranges and all ranges formed therein or thereby;

a wet tensile geometric mean (GM) modulus of greater than about 250 g/cm, or greater than about 375 g/cm, or between about 250 g/cm and about 700 g/cm, or between about 250 g/cm and about 525 g/cm, or between about 375 g/cm and 525 g/cm, specifically reciting all increments of 10 g/cm within the above-recited ranges and all ranges formed therein or thereby;

a CRT rate of greater than about 0.30 g/sec, or greater than about 0.5 g/sec, or greater than about 0.55 g/sec, or greater than about 0.6 g/sec, or greater than about 0.61 g/sec, or greater than about 0.65 g/sec, or greater than about 0.7 g/sec, or greater than about 0.75 g/sec, or greater than about 0.8 g/sec, or between about 0.30 g/sec and about 1.00 g/sec, or between about 0.61 g/sec and about 0.85 g/sec, specifically reciting all increments of 0.05 g/sec within the above-recited ranges and all ranges formed therein or thereby;

a CRT capacity of greater than about 10.0 g/g, or greater than about 12.5 g/g, or between about 12.5 g/g and about 23.0 g/g, or between about 16.5 g/g and about 21.5 g/g, specifically reciting all increments of 0.1 g/g within the above-recited ranges and all ranges formed therein or thereby; a kinetic CoF of greater than about 0.75, or greater than about 0.85, or between about 0.85 and about 1.30, or between about 0.77 and about 1.7, or between about 0.85 and about 1.20, specifically reciting all increments of 0.05 within the above-recited ranges and all ranges formed therein or thereby;

a dry depth of more negative than -240 um, or more negative than -255um, or more negative than -265um, or more negative than -275um, or more negative than -285um, or more negative than -295um, or more negative than -300um, or between about -240um and about -310 um, or between about -245 um and about -305 um, or between about -255 um and about -303 um, or between about -265 um and about -302 um, or between about -275 um and about -300 um, specifically reciting all increments of 20 um within the above-recited ranges and all ranges formed therein or thereby;

a moist depth of more negative than -275um, or more negative than -285 um, or more negative than -295 um, or more negative than -300 um, or more negative than -310 um, or more negative than -320 um, or more negative than -330 um, or between about -275 um and about -340 um, or between about -285 um and about -335 um, or between about -295 um and about -332 um, or between about -300 um and about -330 um, or between about -305um and about -328 um, specifically reciting all increments of 20 um within the above-recited ranges and all ranges formed therein or thereby;

a moist contact area of greater than 25%, or greater than 27%, or greater than 29%, or greater than 31%, or greater than 32%, or greater than 34%, or greater than 36%, or between about 25% and about 38%, or between about 27% and about 37%, or between about 29% and about 36%, or between about 30% and about 35%, or between about 31% and about 34%, specifically reciting all increments of 1% within the above-recited ranges and all ranges formed therein or thereby;

a dry contact area of greater than 17%, or greater than 20%, or greater than 22%, or greater than 24%, or greater than 26%, or greater than 28%, or greater than 30%, or between about 17% and about 33%, or between about 20% and about 31%, or between about 22% and about 30%, or between about 23% and about 30%, or between about 24% and about 29%, specifically reciting all increments of 1% within the above-recited ranges and all ranges formed therein or thereby;

a dry compression (at 10 g force in mils) of greater than about 30 mils, or greater than about 45 mils, or greater than about 50 mils, or greater than about 55 mils, or greater than about 60 mils, or greater than about 65 mils, or greater than about 70, or greater than about 85 mils, or between about 40 mils and about 100 mils, or between about 50 mils and about 80 mils, or between about 50 mils and about 65 mils, or between about 50 mils and about 60 mils, or between about 55 mils and about 60 mils, specifically reciting all increments of 5 mil within the above-recited ranges and all ranges formed therein or thereby;

a wet compression (at 10g force value) in mils of greater than about 30 mils, or greater than about 20 mils, or greater than about 30 mils, or greater than about 40 mils, or greater than about 50 mils, or greater than about 55, or greater than about 60 mils, or greater than about 70 mils, or between about 30 mils and about 100 mils, or between about 40 mils and about 70 mils, or between about 45 mils and about 60 mils, or between about 47 mils and about 58 mils, or between about 50 mils and about 55 mils, specifically reciting all increments of 5 mils within the above-recited ranges and all ranges formed therein or thereby;

a dry bulk ratio of greater than about 15, or greater than about 18, or greater than about 22, or greater than about 25, or greater than about 27, or greater than about 33, or greater than about

35, or greater than about 40, or greater than about 50, or between about 15 and about 60, or between about 22 and about 50, or between about 25 and about 35, or between about 27 and about 35, or between about 27 and about 33, specifically reciting all increments of 0.5 within the above-recited ranges and all ranges formed therein or thereby;

5 a wet bulk ratio of greater than about 20, or greater than about 22, or greater than about 25, or greater than about 28, or greater than about 30, or greater than about 34, or greater than about 40, or greater than about 45, or greater than about 50, or greater than about 55, or between about 22 and about 50, or between about 20 and about 50, or between about 25 and about 45, or between about 28 and about 40, or between about 30 and about 34, specifically reciting all increments of
10 0.5 inches within the above-recited ranges and all ranges formed therein or thereby;

a wet burst strength to dry tensile ratio ("wet burst/dry tensile ratio" which is wet burst strength divided by dry tensile) of greater than about 0.05, greater than about 0.09, greater than about 0.1, greater than about 0.15, greater than about 0.18, greater than about 0.20, greater than about 0.24, or greater than about 0.26, or between about 0.05 and about 0.27, or between about
15 0.15 and about 0.26, or between about 0.20 and about 0.26;

a wet burst strength to dry burst strength ratio ("wet/dry burst strength ratio" which is wet burst strength divided by dry burst strength) of greater than about 0.09, or greater than about 0.10, or greater than about 0.18, or greater than about 0.19, or greater than about 0.20, or greater than about 0.30, or greater than about 0.40, or between about 0.10 and about 0.50, or between about
20 0.20 and about 0.48, or between about 0.30 and about 0.46, or between about 0.40 and about 0.46; a concavity ratio measurement of greater than about 0.1, or greater than about 0.15, or greater than about 0.20, or greater than about 0.25, or greater than about 0.30, or greater than about 0.35, or greater than about 0.40, or greater than about 0.45, or greater than about 0.50, or greater than about 0.55, or greater than about 1.0, or greater than about 1.25, or greater than about 1.5, or
25 between about 0.10 and about 0.95, or between about 0.15 and about 0.90, or between about 0.20 and about 0.85, specifically reciting all increments of 0.01 within the above-recited ranges and all ranges formed therein or thereby; and/or

a packing fraction measurement of greater than about 0.05, or greater than about 0.08, or greater than about 0.10, or greater than about 0.12, or greater than about 0.15, or greater than about
30 0.17, or between about 0.05 and about 0.75, or between about 0.10 and about 0.80, or between about 0.15 and about 0.85, specifically reciting all increments of 0.01 within the above-recited ranges and all ranges formed therein or thereby.

Fibrous structure(s) of the present disclosure comprising or consisting of short fibers may have one or a combination of the above properties (disclosed in this Properties of Fibrous Structure(s) Section).

5 Softness

On its face, it should be easy to make a sanitary tissue product comprising a high short fiber content soft. However, limiting the use of long fibers limits the potential strength of the substrate. Higher amounts of short fibers need to be modified with refining and/or strength chemistries to enable an equivalent amount of strength. This leaves a lower percentage of other fibers (versus
10 traditional or conventional substrates using more long fibers) left that can contribute to the softness, hence an inherent contradiction between high short fiber inclusion and softness. These are challenges that the inventors of the present disclosure have overcome.

Slip-Stick

15 One way to achieve a lower slip-stick is by lowering the contact area of a substrate in the apparatus. This can be achieved by having a more structured sheet. However, structuring the sheet becomes more difficult when the sheet comprises a high short fiber content; this is due to the challenges associated with transporting an unevenly supported, nascent web through the making process. Selective dewatering during processing and/or careful choice of structuring fabrics may
20 be employed to mitigate the challenges of making these structured webs with high amounts of short fibers.

Another way to lower slip-stick is by having a softer, more mobile surface. More mobile fibers, however, are less strong in the network because they are less bonded. Because high amounts of short fibers require a higher percentage to be bonded, lowering slip-stick is a challenge of
25 making sanitary tissue products comprising high amounts of short fibers. The inventors of the present disclosure have overcome said challenges.

Perforations

A step in the conversion of single ply parent rolls into single or multiply finished product
30 rolls that are intended for final consumer use is the perforation process. In this process, the web(s) enter rotary knives that are sectioned to create failure points along the web. The purpose of these failure points is to divide the finished product rolls into sheets for dispensing by the final user.

The distance between the notches and the teeth in the perforation blade and the relative size of both of those features is important. Given that a sanitary tissue web is comprised of fibers, the size of the fibers is important in the perforation system as well. Key metrics in a perforation system include perforation tensile, perforation elongation, and perforation TEA.

5 Inventors have found that at a given percent bonded area of a perforation, there is a strong relationship between the weight weighted mean fiber length of a substrate and the length of the land area in a perforation. Specifically, at a given bond area, as the size of the lands (and therefore perforation size as well) goes down, the tensile, stretch, or TEA of the web perforation goes up. This phenomenon is amplified as the weight weighted mean fiber length of the
10 substrate goes down.

It is hypothesized that the cause for strong dependence between perforation land size, weight weighted mean fiber length, and perforation performance is rooted a relationship between fiber length and tear. In this relationship, at a given tensile strength, as the inclusion of long
15 fibers goes up in substrate, the tear increases. It is thought to be that long fibers have the ability to bond in multiple parts of the sheet, and at distances that are farther from the point of tear, due to their longer length. This then increases the force required to continue to propagate the tear, as the longer fibers must either be torn themselves or fail in multiple locations in the sheet as they are pulled out. This logic would apply to a perforation land as well, where the tear propagates to the end of land before reaching the perforation. In a system with an ample amount of long fibers,
20 the force is distributed due to the fiber length, so the importance of land size at a given bond area is somewhat muted; in a substrate having a high inclusion of short fibers, the rapid tear propagation occurs all the way across the land and then stops at a perforation, and may pick up again on the next land or be delayed. This tear pause induced by the high frequency of perforations has the net effect of increasing the perf tensile, elongation, and TEA of a
25 perforation; this can be particularly desirable for substrates with low weight weighted fiber lengths.

Roll Properties

Higher levels of short fibers limit the ability to mold out of plane and develop caliper
30 through structuring due to dewatering constraints previously discussed. Therefore, it is difficult with high inclusion short fiber substrates to make a high bulk roll that has low compressibility.

Large rolls have a consumer perceived benefit on the shelf. A larger diameter roll at a given price is normally preferred by the consumer. When the consumer unpackages that roll and

uses it, the consumer also wants that same large roll to have just the right level of firmness. Overly soft rolls connote inferiority, and overly firm rolls connote roughness and lack of absorbency. From a manufacturing perspective, however, a roll of toilet tissue can be most cost effectively produced with a minimum amount of fiber mass, while effectively distributing that mass in such a way that the substrate still has superior strength, absorbency, and softness attributes.

The underlying cause of this roll bulk-roll firmness contradiction may be due to the compression/relaxation characteristics of the substrate. It is therefore an unmet consumer need to design a substrate that comprises high percentages of short fiber, yet can be wound into finished product rolls that are both bulky and firm.

As indicated in other parts of this disclosure, fibrous structures, such as sanitary tissue products, may be comprised of substantial amounts of eucalyptus fibers (especially at the consumer-facing layer of a sheet), which are short, narrow, and low exhibit low coarseness. These attributes allow for improved molding into a structured fabric, impacting density and compressibility/resiliency characteristics of the web.

The inventors of the present disclosure have surprisingly shown that substrates and rolls comprising high inclusion short fiber content can be created with good roll bulk and roll compression characteristics.

In addition to the beneficial properties as detailed in the disclosure above, the new fibrous structures detailed herein comprising high inclusions of short fibers permit the fibrous structure manufacturer to wind rolls with high roll bulk (for example greater than $4 \text{ cm}^3/\text{g}$), and/or greater roll firmness (for example between about 2.5 mm to about 15 mm), and/or lower roll percent compressibility (low percent compressibility, for example less than 10% compressibility).

“Roll Bulk” as used herein is the result of measuring finished product rolls. The rolls are placed into a controlled temperature and Humidity room (TAPPI conditions, about $23^\circ\text{C} \pm 2^\circ\text{C}$ and about $50\% \pm 2\%$ relative humidity) for at least 24 hours to equilibrate (equilibration can be monitored by measuring roll weight every 4 hours until the mass stabilizes;). If rolls have been stored in greater than 50% relative humidity conditions, then said rolls should first be equilibrated at conditions lower than 50% relative humidity and then equilibrated at TAPPI conditions – see T-402. The rolls are weighed with the weight recorded to the hundredths of grams. The width of the rolls are measured with a ruler that shows millimeters, width recorded to the tenths of centimeter. Roll Diameter is measured according to the Percent Roll Compressibility test method included herein. Roll Bulk (cm^3/g) is then calculated by: multiplying the square of the radius of

the roll (roll diameter (cm) / 2) by 3.14159 and by the roll width (cm), then dividing that by the mass of the roll (g):

$$\text{Roll Bulk} \left(\frac{\text{cc}}{\text{g}} \right) = \frac{3.14159 * \left(\frac{\text{roll diameter (cm)}}{2} \right)^2 * \text{roll width (cm)}}{\text{roll weight (g)}}$$

5

The measurements are done with the roll core in place. The units “cc/g” are used interchangeably herein with “cm³/g.”

The new rolled fibrous structures (e.g., sanitary tissue products) of the present disclosure may exhibit a roll bulk of greater than about 4 cm³/g, greater than about 5 cm³/g, greater than about 6 cm³/g, greater than about 7 cm³/g, greater than about 8 cm³/g, greater than about 9 cm³/g, greater than about 10 cm³/g, greater than about 12 cm³/g, greater than about 13 cm³/g, greater than about 14 cm³/g, greater than about 15 cm³/g, greater than about 16 cm³/g, greater than about 17 cm³/g, and/or less than about 30 cm³/g, less than about 25 cm³/g, less than about 22 cm³/g, less than about 20 cm³/g, and/or from about 10 cm³/g to about 25 cm³/g, specifically including all 0.1 increments between the recited ranges. Further regarding roll bulk, refer to FIGS. 2A and 2B.

Additionally, examples of the new rolled fibrous structures detailed herein may exhibit a roll firmness less than about 10.5 mm, less than about 9.5 mm, less than 8.5 mm, less than about 7 mm, or from about 2.5 mm to about 15 mm and/or from about 3 mm to about 13 mm, from about 4 mm to about 10 mm, and/or from about 6 to about 9 mm, specifically including all 0.1 increments between the recited ranges. Further regarding roll firmness, refer to FIG. 2B.

Additionally, examples of the new fibrous structures detailed herein may be in the form of a rolled tissue products (single-ply or multi-ply), for example a dry fibrous structure roll, and may have a percent compressibility of less than about 10%, less than about 8%, less than about 7%, less than about 6%, less than about 5%, less than about 4.5%, less than about 4%, less than about 3%, about 0%, greater than about 0.25%, greater than about 1%, from about 2.5% to about 5%, from about 3% to about 5.5%, from about 4% to about 10%, from about 4% to about 8%, from about 4% to about 7%, and/or from about 4% to about 6%, as measured according to the Percent Compressibility Test Method described herein.

Additionally, examples of the new rolled tissue products as detailed herein can be individually packaged to protect the fibrous structure from environmental factors during shipment, storage, and shelving for retail sale. Any of known methods and materials for wrapping bath tissue or paper towels can be utilized. Further, the plurality of individual packages, whether individually

wrapped or not, can be wrapped together to form a package having inside a plurality of the new rolled tissue products as detailed herein. The package can have 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16 or more rolls. In such packages, the roll bulk and percent compressibility can be important factors in package integrity during shipping, storage, and shelving for retail sale. Further, the plurality of individual packages, or the packages having a plurality of the new rolled tissue products as detailed herein, can be palletized (i.e., organized and/or transported on a pallet). In such pallets of the new rolled tissue products as detailed herein, the roll bulk and percent compressibility can be important factors in package integrity during shipping, storage, and shelving for retail sale.

Further, a package of a plurality of individual rolled tissue products, in which at least one of the rolled tissue products exhibits a roll bulk of greater than about 4 cm³/g or a percent compressibility of less than about 10%, or less than about 8%, is contemplated. In one example, a package of a plurality of individual rolled tissue products, in which at least one of the rolled tissue products exhibits a roll bulk of greater than about 4 cm³/g and a percent compressibility of less than about 10%, or less than about 8%, is contemplated. In another example, a package of a plurality of individual rolled tissue products, in which at least one of the rolled tissue products exhibits a roll bulk of greater than about 6 cm³/g and a percent compressibility of less than about 8%, or less than about 5%, is contemplated.

U.S. Publication No. 2022-0031531 discloses the packages that may be desirable for containing the rolled fibrous structures of the present disclosure, including sanitary tissue products (e.g., bath tissue). Said packages may comprise short fibers, just like the rolled fibrous structures the package is used contained.

FIBROUS STRUCTURE EXAMPLES

Further nonlimiting examples of the new fibrous structures that include the various inventive short fiber inclusion(s), as detailed herein, may have the properties disclosed in the tables of FIGS. 18-1 through 18-5 and as illustrated in FIGS. 1A-R and 2A-B and may be used to form sanitary tissue products of the present disclosure.

FIGS. 18-1 through 18-5 are tables illustrating multiple inventive and comparative embodiments, specifically detailing multiple properties for the purpose of comparing inventive versus comparative embodiments (note: common numbers between the tables indicate the same sample).

Papermaking Example 1

An example of fibrous structures in accordance with the present disclosure can be prepared using a papermaking machine as described above with respect to FIG. 6A, and according to the method described below:

5 An aqueous slurry of eucalyptus pulp fibers is prepared at about 3% fiber by weight using a conventional repulper, then transferred to a hardwood fiber stock chest. The eucalyptus fiber slurry of the hardwood stock chest is pumped through a stock pipe to a hardwood fan pump where the slurry consistency is reduced from about 3% by fiber weight to about 0.15% by fiber weight. The 0.15% eucalyptus slurry is then pumped and distributed in the top chamber of a multi-layered, 10 three-chambered headbox of a Fourdrinier wet-laid papermaking machine.

 Additionally, an aqueous slurry of eucalyptus pulp fibers is prepared at about 3% fiber by weight using a conventional repulper, then transferred to a hardwood fiber stock chest. The eucalyptus fiber slurry of the hardwood stock chest is pumped through a stock pipe and mixed with the aqueous slurry of Northern Softwood Kraft (NSK), described in the next paragraph, to a fan 15 pump where the slurry consistency is reduced from about 1.5% by fiber weight to about 0.15% by fiber weight. The 0.15% eucalyptus/NSK slurry is then pumped and distributed in the center and bottom chamber of a multi-layered, three-chambered headbox of a Fourdrinier wet-laid papermaking machine.

 Additionally, an aqueous slurry of NSK (Northern Softwood Kraft) pulp fibers is prepared 20 at about 1.5-3% fiber by weight using a conventional repulper, then transferred to the softwood fiber stock chest. The NSK fiber slurry of the softwood stock chest is pumped through a stock pipe to be refined to a Canadian Standard Freeness (CSF) of about 630. The refined NSK fiber slurry is then mixed with the 3% aqueous slurry of Eucalyptus fibers (described in the preceding paragraph) and directed to a fan pump where the NSK slurry consistency is reduced from about 3% by fiber 25 weight to about 0.15% by fiber weight. The 0.15% Eucalyptus/NSK slurry is then directed and distributed to the center and bottom chamber of a multi-layered, three-chambered headbox of a Fourdrinier wet-laid papermaking machine.

 In order to impart temporary wet strength to the finished fibrous structure, a 1% dispersion of temporary wet strengthening additive (e.g., Fennorez®91 commercially available from 30 Kemira) is prepared and is added to the NSK or non-wood or eucalyptus fiber stock pipe at a rate sufficient to deliver 0.25% temporary wet strengthening additive based on the dry weight of the fibers. The absorption of the temporary wet strengthening additive is enhanced by passing the treated slurry through an in-line mixer.

The wet-laid papermaking machine has a layered headbox having a top chamber, a center chamber, and a bottom chamber where the chambers feed directly onto the forming wire (Fourdrinier wire). The eucalyptus fiber slurry of 0.15% consistency is directed to the top headbox chamber. Alternatively, a non-wood fiber slurry can be directed to the top headbox chamber. The
5 NSK/Eucalyptus, NSK/non-wood, non-wood/eucalyptus, or non-wood fiber slurry is directed to the center and bottom headbox chambers. All three fiber layers are delivered simultaneously in superposed relation onto the Fourdrinier wire to form thereon a three-layer embryonic fibrous structure (web), of which about 40% of the top side is made up of the eucalyptus and or non-wood fibers, and about 60% of the sheet can be made of various blends of non-wood, NSK, and
10 eucalyptus fibers, directed towards the center and bottom layers. Dewatering occurs through the Fourdrinier wire and is assisted by a deflector and wire table vacuum boxes. The Fourdrinier wire is a Legent 866A Dual Layer (0.11 mm x 0.18 mm, Asten Johnson). The speed of the Fourdrinier wire is about 800 feet per minute (fpm).

The embryonic wet fibrous structure is transferred from the Fourdrinier wire, at a fiber
15 consistency of about 18-22% at the point of transfer, to a 3D patterned, continuous knuckle, through-air-drying belt as shown in FIG. 3. The speed of the 3D patterned through-air-drying belt is 800 feet per minute (fpm), which is the same speed of the Fourdrinier wire. The 3D patterned through-air-drying belt is designed to yield a fibrous structure comprising a pattern of continuous high density knuckle region oriented approximately 75 Degrees relative to the cross
20 direction. Each continuous high density knuckle region oriented approximately 75 Degrees relative to the cross direction is separated by a low-density discrete pillow region oriented approximately 75 Degrees relative to the cross direction. This 3D patterned through-air-drying belt is formed by casting a layer of an impervious resin surface of a continuous knuckle onto a fiber mesh supporting fabric. The supporting fabric is a 98 x 52 filament, dual layer mesh. The
25 thickness of the resin cast is about 12.0 mils above the supporting fabric. Alternatively, the drying fabric is designed to yield a pattern of substantially machine direction oriented linear channels having a continuous network of high density (knuckle) areas. This drying fabric is formed by casting an impervious resin surface onto a fiber mesh supporting fabric. The supporting fabric is a 98 x 52 filament, dual layer mesh. The thickness of the resin cast is about 12 mils above the
30 supporting fabric. The area of the continuous network is about 40 percent of the surface area of the drying fabric.

Further de-watering of the fibrous structure is accomplished by vacuum assisted drainage until the fibrous structure has a fiber consistency of about 20% to 30%.

While remaining in contact with the 3D patterned through-air-drying belt, the fibrous structure is pre-dried by air blow-through pre-dryers to a fiber consistency of about 50-65% by weight.

After the pre-dryers, the semi-dry fibrous structure is transferred to a Yankee dryer and
5 adhered to the surface of the Yankee dryer with a sprayed creping adhesive. The creping
adhesive is an aqueous dispersion with the actives consisting of about 80% polyvinyl alcohol
(PVA 88-44), about 20% CREPETROL® 5688. CREPETROL® 5688 is commercially available
from Solenis. The creping adhesive is delivered to the Yankee surface at a rate of about 0.10-
0.20% adhesive solids based on the dry weight of the fibrous structure. The fiber consistency is
10 increased to about 96-98% before the fibrous structure is dry-creped from the Yankee with a
doctor blade.

The doctor blade has a bevel angle of about 15-25° and is positioned with respect to the
Yankee dryer to provide an impact angle of about 71-81°. The Yankee dryer is operated at a
temperature of about 275-350°F and a speed of about 800 fpm. The fibrous structure is wound in
15 a roll (parent roll) using a surface driven reel drum having a surface speed of about 550-700 fpm.

Two parent rolls of the fibrous structure are then converted into a sanitary tissue product
by loading the roll of fibrous structure into an unwind stand. The two parent rolls are converted
with the low-density pillow side out. Alternatively, they can be converted with the high-density
knuckle side out. The line speed is 550 ft/min. One parent roll of the fibrous structure is unwound
20 and transported to an emboss stand where the fibrous structure is strained to form the emboss
pattern in the fibrous structure via a 0.56" Pressure Roll Nip and then combined with the fibrous
structure from the other parent roll to make a multi-ply (2-ply) sanitary tissue
product. Approximately 0.5% of a proprietary quaternary amine softener is added to the top side
of the multi-ply sanitary tissue product. Approximately 0.5% of a proprietary quaternary amine
25 softener may also be added to the bottom side of the multi-ply sanitary tissue product. The multi-
ply sanitary tissue product is then transported to a winder where it is wound onto a core to form a
log. The log of multi-ply sanitary tissue product is then transported to a log saw where the log is
cut into finished multi-ply sanitary tissue product rolls. The molding member used to make the
multi-ply sanitary tissue product of this example exhibits the dimensions shown in Table 4 of U.S.
30 Serial No. 17/238,527 filed April 23, 2021, and assigned to The Procter & Gamble Company.

Papermaking Example 2

An example of fibrous structures in accordance with the present disclosure can be prepared using a papermaking machine as described above with respect to FIG. 6A, and according to the method described below:

5 An aqueous slurry of eucalyptus pulp fibers is prepared at about 3% fiber by weight using a conventional repulper, then transferred to a hardwood fiber stock chest. The eucalyptus fiber slurry of the hardwood stock chest is pumped through a stock pipe to a hardwood fan pump where the slurry consistency is reduced from about 3% by fiber weight to about 0.15% by fiber weight. The 0.15% eucalyptus slurry is then pumped and distributed in the top chamber of a multi-layered,
10 three-chambered headbox of a Fourdrinier wet-laid papermaking machine.

 Additionally, an aqueous slurry of eucalyptus pulp fibers is prepared at about 3% fiber by weight using a conventional repulper, then transferred to a hardwood fiber stock chest. The eucalyptus fiber slurry of the hardwood stock chest is pumped through a stock pipe to be refined to a Canadian Standard Freeness (CSF) of about 630 using plates of a low intensity design, such
15 as BJFC1616615061030 plates made by Finebar Aikawa Group. The refined eucalyptus fiber slurry is then mixed with Redibond 5330 starch and then Calaxis HM-100C CMC. The blend of refined and chemically treated eucalyptus of the hardwood stock chest is pumped to a fan pump where the slurry consistency is reduced from about 3% by fiber weight to about 0.15% by fiber weight. The 0.15% refined and chemically treated eucalyptus slurry is then pumped and distributed
20 in the center and bottom chamber of a multi-layered, three-chambered headbox of a Fourdrinier wet-laid papermaking machine.

 In order to impart temporary wet strength to the finished fibrous structure, a 1% dispersion of temporary wet strengthening additive (e.g., Fennorez®91 commercially available from Kemira) is prepared and is added to the eucalyptus or the refined, chemically treated eucalyptus
25 fiber stock pipe at a rate sufficient to deliver 0.25% temporary wet strengthening additive based on the dry weight of the fibers. The absorption of the temporary wet strengthening additive is enhanced by passing the treated slurry through an in-line mixer.

 The wet-laid papermaking machine has a layered headbox having a top chamber, a center chamber, and a bottom chamber where the chambers feed directly onto the forming wire (Fourdrinier wire). The eucalyptus fiber slurry of 0.15% consistency is directed to the top headbox chamber. Alternatively, a non-wood fiber slurry can be directed to the top headbox chamber. The
30 NSK/Eucalyptus, NSK/non-wood, non-wood/eucalyptus, refined and chemically treated eucalyptus, or non-wood fiber slurry is directed to the center and bottom headbox chambers. All

three fiber layers are delivered simultaneously in superposed relation onto the Fourdrinier wire to form thereon a three-layer embryonic fibrous structure (web), of which about 40% of the top side is made up of the eucalyptus and or non-wood fibers, and about 60% of the sheet can be made of various blends of non-wood, NSK, and eucalyptus fibers, directed towards the center and bottom layers. IDewatering occurs through the Fourdrinier wire and is assisted by a deflector and wire table vacuum boxes. The Fourdrinier wire is a Legent 866A Dual Layer (0.11 mm x 0.18 mm, Asten Johnson). The speed of the Fourdrinier wire is about 800 feet per minute (fpm).

The embryonic wet fibrous structure is transferred from the Fourdrinier wire, at a fiber consistency of about 18-22% at the point of transfer, to a 3D patterned, continuous knuckle, through-air-drying belt as shown in FIG. 3. The speed of the 3D patterned through-air-drying belt is 800 feet per minute (fpm), which is the same speed of the Fourdrinier wire. The 3D patterned through-air-drying belt is designed to yield a fibrous structure comprising a pattern of continuous high density knuckle region oriented approximately 75 Degrees relative to the cross direction. Each continuous high density knuckle region oriented approximately 75 Degrees relative to the cross direction is separated by a low-density discrete pillow region oriented approximately 75 Degrees relative to the cross direction. This 3D patterned through-air-drying belt is formed by casting a layer of an impervious resin surface of a continuous knuckle onto a fiber mesh supporting fabric. The supporting fabric is a 98 x 52 filament, dual layer mesh. The thickness of the resin cast is about 12.0 mils above the supporting fabric. Alternatively, the drying fabric is designed to yield a pattern of substantially machine direction oriented linear channels having a continuous network of high density (knuckle) areas. This drying fabric is formed by casting an impervious resin surface onto a fiber mesh supporting fabric. The supporting fabric is a 98 x 52 filament, dual layer mesh. The thickness of the resin cast is about 12 mils above the supporting fabric. The area of the continuous network is about 40 percent of the surface area of the drying fabric.

Further de-watering of the fibrous structure is accomplished by vacuum assisted drainage until the fibrous structure has a fiber consistency of about 20% to 30%.

While remaining in contact with the 3D patterned through-air-drying belt, the fibrous structure is pre-dried by air blow-through pre-dryers to a fiber consistency of about 50-65% by weight.

After the pre-dryers, the semi-dry fibrous structure is transferred to a Yankee dryer and adhered to the surface of the Yankee dryer with a sprayed creping adhesive. The creping adhesive is an aqueous dispersion with the actives consisting of about 80% polyvinyl alcohol

(PVA 88-44), about 20% CREPETROL® 5688. CREPETROL® 5688 is commercially available from Solenis. The creping adhesive is delivered to the Yankee surface at a rate of about 0.10-0.20% adhesive solids based on the dry weight of the fibrous structure. The fiber consistency is increased to about 96-98% before the fibrous structure is dry-creped from the Yankee with a doctor blade.

The doctor blade has a bevel angle of about 15-25° and is positioned with respect to the Yankee dryer to provide an impact angle of about 71-81°. The Yankee dryer is operated at a temperature of about 275-350°F and a speed of about 800 fpm. The fibrous structure is wound in a roll (parent roll) using a surface driven reel drum having a surface speed of about 550-700 fpm.

Two parent rolls of the fibrous structure are then converted into a sanitary tissue product by loading the roll of fibrous structure into an unwind stand. The two parent rolls are converted with the low-density pillow side out. Alternatively, they can be converted with the high-density knuckle side out. The line speed is 550 ft/min. One parent roll of the fibrous structure is unwound and transported to an emboss stand where the fibrous structure is strained to form the emboss pattern in the fibrous structure via a 0.56" Pressure Roll Nip and then combined with the fibrous structure from the other parent roll to make a multi-ply (2-ply) sanitary tissue product. Approximately 0.5% of a proprietary quaternary amine softener is added to the top side of the multi-ply sanitary tissue product. Approximately 0.5% of a proprietary quaternary amine softener may also be added to the bottom side of the multi-ply sanitary tissue product. The multi-ply sanitary tissue product is then transported to a winder where it is wound onto a core to form a log. The log of multi-ply sanitary tissue product is then transported to a log saw where the log is cut into finished multi-ply sanitary tissue product rolls. The molding member used to make the multi-ply sanitary tissue product of this example exhibits the dimensions shown in Table 4 of U.S. Serial No. 17/238,527 filed April 23, 2021, and assigned to The Procter & Gamble Company.

Papermaking Example 3

Same as Papermaking Example 2, except: a long fiber (NSK, SSK, or other fiber greater than 1.0 mm Length Weighted Mean Fiber Length) is prepared in an aqueous slurry of 0.75-3.0% is blended with the chemically treated eucalyptus and added to the bottom headbox chamber after being diluted by a fan pump to approximately 0.15%.

Papermaking Example 4

Each of Papermaking Examples 1-3, further using the papermaking belt(s) described in U.S. Pub. No. 2021-0140115.

5 Papermaking Example 5

Each of Papermaking Examples 1-3, further using the papermaking belt(s) described in U.S. Pub. No. 2020-0181848.

ARRAYS OF THE PRESENT DISCLOSURE

10 Sanitary tissue products within the scope of the present disclosure, including arrays of
sanitary tissues comprising short fibers as disclosed in the ASPECTS OF THE PRESENT
DISCLOSURE herein (including Aspects 5 through 11 herein) may be packaged in packages
comprising sustainable materials (e.g., paper, recycled(able) plastic, corrugated cardboard, plant-
based plastic, etc.) and displayed with other package(s) comprising sanitary tissue product(s) as
15 an array(s) – see for example, U.S. Provisional Patent Application Serial Nos. 63/353,167 and
63/375,858, both titled “Sanitary Tissue Products and Arrays Comprising Non-wood Fibers,”
filed on June 17, 2022 under Attorney Docket No. 16297P and filed on September 16, 2022
under Attorney Docket No. 16297P2, both by The Procter & Gamble Company and both naming
Katherine Schwerdtfeger as the first-named inventor, and which are herein incorporated by
20 reference, for details regarding the different arrays that sanitary tissue products of the present
disclosure may be used to form and for packages that sanitary tissue products of the present
disclosure may be contained in; further, packages comprising sanitary tissue products of the
present disclosure may convey or connote sustainability as disclosed in Attorney Docket Nos.
16297P and 16297P2.

25 ASPECTS OF THE PRESENT DISCLOSURE

The following aspects of the disclosure are exemplary only and not intended to limit the scope of the disclosure:

30 Aspect 1: Sanitary Tissue Product Claim Embodiments (Independent):

1. A sanitary tissue product, comprising:

at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4; and

a dry caliper value greater than about 20.

2. A sanitary tissue product, comprising:
at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4; and
a 1500 CM intercept value greater than about 30.
- 5 3. A sanitary tissue product, comprising:
at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4; and
a 1500 CM slope value less than about -6.
4. A sanitary tissue product, comprising:
10 at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4; and
a 1500 CM slope value less than about -6.
5. A sanitary tissue product, comprising:
at least about 70% short fibers and/or having a weight weighted mean fiber length of less
15 than about 1.4; and
a 200 CM Intercept value greater than about 31.
6. A sanitary tissue product, comprising:
at least about 70% short fibers and/or having a weight weighted mean fiber length of less
than about 1.4; and
20 a CD peak elongation value greater than about 11.
7. A sanitary tissue product, comprising:
at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4; and
a CD tensile modulus less than about 1300.
- 25 8. A sanitary tissue product, comprising:
at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4; and
an MD tensile modulus less than about 720.
9. A sanitary tissue product, comprising:
30 at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4; and

a GM tensile modulus less than about 1100.

10. A sanitary tissue product, comprising:

at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4; and

5 an MD tensile modulus less than about 900.

11. A sanitary tissue product, comprising:

at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4;

a total tensile less than about 900; and

10 a CD tear greater than about 9.

12. A sanitary tissue product, comprising:

at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4;

a total tensile less than about 900; and

15 a MD tear greater than about 10.

13. A sanitary tissue product, comprising:

at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4; and

an MD flexural rigidity less than about 1100.

20 14. A sanitary tissue product, comprising:

at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4; and

a VFS greater than about 10 g/g.

15. A sanitary tissue product, comprising:

25 at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4; and

a 5 sheet stack compressibility slope greater than about 29.

16. A sanitary tissue product, comprising:

30 at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4; and

a 5 sheet residual bulk greater than about 66.

17. A sanitary tissue product, comprising:

at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4; and

a 5 sheet stack compressibility slope x residual bulk greater than about 1500.

5 18. A sanitary tissue product, comprising:

at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4; and

a TS7 less than about 12.

19. A sanitary tissue product, comprising:

10 at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4;

a plate stiffness greater than about 3.9; and

consisting of a first ply and optionally a second ply.

20. A sanitary tissue product, comprising:

15 at least about 70% short fibers and/or having a weight weighted mean fiber length_of less than about 1.4;

a roll bulk greater than about 10; and

a roll compressibility less than about 4.5%.

21. A sanitary tissue product, comprising:

20 first and second layers, wherein the first layer is a top layer and the second layer is a bottom layer;

wherein the top layer is a consumer-facing layer;

wherein the top layer comprises a greater percentage of short fibers than the second layer;

and

25 wherein the second layer has a short fiber content greater than about 50%.

22. A sanitary tissue product, comprising:

a non-consumer-facing layer comprising greater than about 70% short fibers.

23. A sanitary tissue product, comprising:

a non-consumer-facing layer comprising from about 55% to about 100% short fibers.

30

Aspect 2 – Sanitary Tissue Product Claim Embodiments (Dependent):

1. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product has less than 100%.
2. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this
5 Aspect 2, wherein the sanitary tissue product has less than 95%.
3. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product has less than 90%.
4. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product has less than 85%.
- 10 5. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product has less than 80%.
6. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product has less than 75%.
7. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this
15 Aspect 2, wherein the sanitary tissue product is creped.
8. The sanitary tissue product according to any of the preceding claims of Aspect 1, wherein the sanitary tissue product is un-creped.
9. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product is structured.
- 20 10. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product is through-air-dried.
11. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product is multi-ply.
12. The sanitary tissue product according to any of the preceding claims of Aspect 1 (excluding
25 claim 19 of Aspect 1) and this Aspect 2, wherein the sanitary tissue product comprises 3 plies.
13. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers are selected from the group consisting of Acacia, Eucalyptus, Bagasse, Maple, Oak, Aspen, Birch, Cottonwood, Alder, Ash, Cherry, Elm, Hickory, Poplar, Gum, Walnut, Locust, Sycamore, Beech, Catalpa, Sassafras, Gmelina, Albizia, Anthocephalus,
30 Magnolia, and combinations thereof.

14. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise eucalyptus.
15. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise bagasse.
- 5 16. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2 (excluding claims 1-6 of this Aspect 2), comprising at least about 75% short fibers.
17. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2 (excluding claims 1-6 of this Aspect 2), comprising at least about 80% short fibers.
18. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this
10 Aspect 2 (excluding claims 1-6 of this Aspect 2), comprising at least about 90% short fibers.
19. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2 (excluding claims 1-6 of this Aspect 2), comprising at least about 95% short fibers.
20. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2 (excluding claims 1-6 of this Aspect 2), comprising at least about 100% short fibers.
- 15 21. The sanitary tissue product according to any of the preceding claims of Aspect 1, comprising at least about 15% long fibers.
22. The sanitary tissue product according to any of the preceding claims of Aspect 1, comprising at least about 10% long fibers.
23. The sanitary tissue product according to any of the preceding claims of Aspect 1, comprising
20 at least about 5% long fibers.
24. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, having a weight weighted mean fiber length of less than about 1.4.
25. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, having a weight weighted mean fiber length of less than about 1.3.
- 25 26. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, having a weight weighted mean fiber length of less than about 1.2.
27. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, having a weight weighted mean fiber length of less than about 1.1.

28. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, having a weight weighted mean fiber length of less than about 1.0
29. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, having a weight weighted mean fiber length of less than about 0.9.
- 5 30. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims of Aspect 2, wherein the sanitary tissue product comprises:
- a first layer;
 - a second layer; and
 - wherein at least one of the first and second layers comprise softwood fibers.
- 10 31. The sanitary tissue product according to claim 30, wherein the softwood fibers are selected from the group consisting of NSK, SSK, and combinations thereof.
32. The sanitary tissue product according to claim 30, wherein the first layer is a consumer facing layer and comprises NSK, and wherein the second layer comprises SSK.
33. The sanitary tissue product according to claim 30, wherein the second layer is a non-consumer
15 facing layer.
34. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, wherein the sanitary tissue product comprises:
- a first layer;
 - a second layer; and
 - 20 wherein at least one of the first and second layers comprise strength chemistry.
35. The sanitary tissue product according to claim 34, wherein each of the first and second layers comprise strength chemistry.
36. The sanitary tissue product according to claim 35, wherein the first and second layers comprise different percentages of strength chemistry.
- 25 37. The sanitary tissue product according to claim 35, wherein the first and second layers comprise the same percentages of strength chemistry.
38. The sanitary tissue product according to claim 34, wherein the strength chemistry is selected from CMC, starch, gums, polyacrylamide, polyacrylamide derivatives, polyvinyl alcohol, and combinations thereof.

39. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, wherein the sanitary tissue product comprises:

a first layer;

a second layer; and

5 wherein at least one of the first and second layers comprise refined fibers.

40. The sanitary tissue product according to claim 39, wherein each of the first and second layers comprise refined fibers.

41. The sanitary tissue product according to claim 39, wherein the first and second layers comprise different percentages of refined fibers.

10 42. The sanitary tissue product according to claim 39, wherein the first and second layers comprise the same percentages of refined fibers.

43. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, wherein the sanitary tissue product comprises:

a first layer;

15 a second layer; and

wherein each of the first and second layers comprise at least about 65% and/or a weight weighted mean fiber length of less than about 1.5 short fibers.

44. The sanitary tissue product according to claim 43, wherein each of the first and second layers comprise at least about 70% and/or a weight weighted mean fiber length of less than about 1.4
20 short fibers.

45. The sanitary tissue product according to claim 43, wherein each of the first and second layers comprise at least about 75% and/or a weight weighted mean fiber length of less than about 1.3 short fibers.

46. The sanitary tissue product according to claim 43, wherein each of the first and second layers
25 comprise at least about 80% and/or a weight weighted mean fiber length of less than about 1.2 short fibers.

47. The sanitary tissue product according to claim 43, wherein each of the first and second layers comprise at least about 90% and/or a weight weighted mean fiber length of less than about 1.0 short fibers.

48. The sanitary tissue product according to claim 43, wherein each of the first and second layers comprise at least about 100% and/or a weight weighted mean fiber length of less than about 0.9 short fibers.

49. The sanitary tissue product according to claim 43, wherein the first and second layers comprise
5 different percentages of short fibers.

50. The sanitary tissue product according to claim 43, wherein the first and second layers comprise the same percentage of short fibers.

51. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, wherein the sanitary tissue product comprises:
10 a first layer;
a second layer; and
wherein at least one of the first and second layers comprise refined fibers and strength chemistry.

52. The sanitary tissue product according to claim 51, wherein each of the first and second layers
15 comprise refined fibers and strength chemistry.

53. The sanitary tissue product according to claim 51, wherein the first and second layers comprise different percentages of refined fibers and different percentages of strength chemistry.

54. The sanitary tissue product according to claim 51, wherein the first and second layers comprise the same percentages of refined fibers and the same percentages of strength chemistry.

20 55. The sanitary tissue product according to claim 51, wherein the first and second layers comprise the same percentages of refined fibers and different percentages of strength chemistry.

56. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, wherein the sanitary tissue product comprises:
a first layer comprising a first short fiber species;
25 a second layer a second short fiber species; and
wherein the first and second species are different.

57. The sanitary tissue product according to claim 56, wherein the first short fiber species is eucalyptus.

58. The sanitary tissue product according to claim 57, wherein the second short fiber species is
30 bagasse.

59. The sanitary tissue product according to claim 56, wherein the first layer is an outside consumer facing side.

60. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, wherein the sanitary tissue product comprises:

- 5 a first layer comprising eucalyptus; and
- a second layer a eucalyptus and bagasse.

61. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers are less than 1mm.

62. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this
10 Aspect 2, wherein the short fibers are less than 0.9mm.

63. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers are less than 0.8mm.

64. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers are less than 0.7mm.

15 65. The sanitary tissue product according to any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers are less than 0.6mm.

66. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein regions of the sanitary tissue product have different densities.

67. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
20 wherein a first region of the sanitary tissue product has a density at least 30% greater than a second region of the sanitary tissue product.

68. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising pillows.

69. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
25 comprising knuckles.

70. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising pillows and knuckles, wherein density differences between the pillows and knuckles are at least 30% different.

71. The sanitary tissue product of the preceding two claims, wherein the knuckles are more dense
30 than the pillows.

72. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising continuous pillows.
73. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising continuous knuckles.
- 5 74. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein pillows are surrounded by continuous knuckles.
75. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein knuckles are surrounded by continuous pillows.
76. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
10 comprising a greater percentage of pillows than knuckles.
77. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2 (except claim 76), comprising a greater percentage of knuckles than pillows.
78. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising consumer-facing pillows.
- 15 79. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising consumer-facing knuckles.
80. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising consumer-facing peaks and troughs.
81. The sanitary tissue product of the preceding claim, wherein the peaks and troughs have different
20 densities.
82. The sanitary tissue product of the preceding two claims, wherein at least a portion of the peaks and the troughs have at least 30% density differences.
83. The sanitary tissue product of the preceding two claims, wherein the troughs are more dense than the peaks.
- 25 84. The sanitary tissue product of the preceding three claims, wherein the troughs, a consumer-facing side of the sanitary tissue product, are lower than the peaks.
85. The sanitary tissue product of claims 68-79 wherein the pillows, on a consumer-facing side of the sanitary tissue product, face outwardly.

86. The sanitary tissue product of claims 68-79 wherein the knuckles, on a consumer-facing side of the sanitary tissue product, face outwardly.

87. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the sanitary tissue product is embossed.

5 88. The sanitary tissue product of any of the preceding claims 1-18 of Aspect 1 and any of the preceding claims of 1-10 and 13-87 of this Aspect 2, wherein the sanitary tissue product consists of a single ply.

89. The sanitary tissue product of any of the preceding claims 1-18 of Aspect 1 and any of the preceding claims of 1-10 and 13-87 of this Aspect 2, wherein the sanitary tissue product comprises
10 2 plies.

90. The sanitary tissue product of any of the preceding claims 1-18 of Aspect 1 and any of the preceding claims of 1-10 and 13-87 of this Aspect 2, wherein the sanitary tissue product comprises 3 plies.

91. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any
15 of the preceding claims 1-29 of Aspect 2, wherein each ply of the sanitary tissue product consists of a single layer.

92. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, wherein each ply of sanitary tissue product comprises 2 layers.

20 93. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, comprising a ply, the ply comprising a first layer and a second layer, wherein the first layer is a consumer facing layer, and wherein the second layer does not comprise short fibers.

94. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any
25 of the preceding claims 1-29 of Aspect 2, comprising a ply, the ply comprising a first layer and a second layer, wherein the first layer is a consumer facing layer, and wherein the first and second layers comprise substantially equal amounts of short fibers.

95. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, comprising a ply comprising a first layer and a second
30 layer, wherein the first layer is a consumer facing layer, and wherein the first layer comprises a greater amount of short fiber than the second layer.

96. The sanitary tissue product according to any of the preceding claims 1-20 of Aspect 1 and any of the preceding claims 1-29 of Aspect 2, comprising a ply comprising a first layer and a second layer, wherein the first layer is a consumer-facing layer, wherein the consumer-facing layer has a consumer facing side, wherein the consumer-facing side comprises a plurality of pillows.
- 5 97. The sanitary tissue product of any of the preceding claims of Aspect 1, wherein a consumer-facing side of the sanitary tissue product is FSO.
98. The sanitary tissue product of any of the preceding claims of Aspect 1, wherein a consumer-facing side of the sanitary tissue product is WSO.
99. The sanitary tissue product of any of the preceding claims of Aspect 1, wherein a first
10 consumer-facing side of the sanitary tissue product is FSO and a second consumer-facing side of the sanitary tissue product is WSO.
100. The sanitary tissue product of any of the preceding claims of Aspect 1, comprising synthetic fibers.
101. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
15 wherein the sanitary tissue product is a paper towel.
102. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2 (except claim 101), wherein the sanitary tissue product is a bath tissue.
103. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2 (except claims 101 and 102), wherein the sanitary tissue product is a facial tissue.
- 20 104. The roll of sanitary tissue product of any of the preceding claims of Aspect 1 (except claim 18) and this Aspect 2, comprising a TS7 of less than about 14 dB V² rms.
105. The sanitary tissue product of any of the preceding claims of Aspect 1 (except claim 18) and this Aspect 2, comprising a TS7 of less than about 13 dB V² rms.
106. The sanitary tissue product of any of the preceding claims of Aspect 1 (except claim 18) and
25 this Aspect 2, comprising a TS7 of less than about 12 dB V² rms.
107. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 of less than about 11 dB V² rms.
108. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 of less than about 10 dB V² rms.

109. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 of less than about 9 dB V² rms.
110. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 of less than about 8 dB V² rms.
- 5 111. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 of less than about 7 dB V² rms.
112. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 of less than about 6 dB V² rms.
113. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
10 comprising a TS7 greater than about 1 dB V² rms.
114. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 greater than about 2 dB V² rms.
115. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 greater than about 3 dB V² rms.
- 15 116. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a TS7 greater than about 4 dB V² rms.
117. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a compressive slope (Dry-1500) of less than about 12 mil/g.
118. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
20 comprising a compressive slope (Dry-1500) of less than about 11 mil/g.
119. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a compressive e slope (Dry-1500) of less than about 10 mil/g.
120. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a compressive slope (Dry-1500) of less than about 9 mil/g.
- 25 121. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a compressive slope (Dry-1500) of less than about 8 mil/g.
122. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a compressive slope (Dry-1500) of greater than about 3 mil/g.

123. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a compressive slope (Dry-1500) of greater than about 5 mil/g.
124. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a compressive slope (Dry-1500) of greater than about 6 mil/g.
- 5 125. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a formation index of greater than about 50.
126. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a formation index of greater than about 60.
127. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
10 comprising a formation index of greater than about 70.
128. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a formation index of greater than about 80.
129. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a formation index of greater than about 90.
- 15 130. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a formation index of less than about 165.
131. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a formation index of less than about 155.
132. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
20 comprising a formation index of less than about 145.
133. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a coverage of greater than about 2 fiber layers.
134. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a coverage of greater than about 3 fiber layers.
- 25 135. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a coverage of greater than about 4 fiber layers.
136. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2 comprising a coverage of greater than about 5 fiber layers.

137. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a coverage of greater than about 6 fiber layers.

138. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a coverage of less than about 10.

5 139. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a coverage of less than about 9.

140. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a coverage of less than about 8.

10 141. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness of greater than about 0.15 mg/m.

142. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness (according to the Coverage and Fiber Count Test Method) of greater than about 0.17 mg/m.

15 143. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness (according to the Coverage and Fiber Count Test Method) of greater than about 0.19 mg/m.

144. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness (according to the Coverage and Fiber Count Test Method) greater than about 0.21 mg/m.

20 145. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness (according to the Coverage and Fiber Count Test Method) of greater than about 0.23 mg/m.

25 146. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness (according to the Coverage and Fiber Count Test Method) of greater than about 0.24 mg/m.

147. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness (according to the Coverage and Fiber Count Test Method) of less than about 0.25 mg/m.

148. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness (according to the Coverage and Fiber Count Test Method) of less than about 0.32 mg/m.

149. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
5 comprising a fiber count (number average) greater than about 3 million fibers per gram.

150. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a fiber count (number average) greater than about 12 million fibers per gram.

151. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a fiber count (number average) greater than about 10 million fibers per gram.

10 152. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2 comprising a fiber count (number average) greater than about 15 million fibers per gram.

153. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a fiber count (number average) greater than about 20 million fibers per gram.

154. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
15 comprising a fiber count (number average) less than about 25 million fibers per gram.

155. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a fiber count (number average) less than about 30 million fibers per gram.

156. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a fiber count (number average) less than about 35 million fibers per gram.

20 157. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise a fiber length/width ratio of less than about 183.

158. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise a fiber length/width ratio of less than about 175.

159. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
25 wherein the short fibers comprise a fiber length/width ratio of less than about 150.

160. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise a fiber length/width ratio of less than about 125.

161. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise a fiber length/width ratio of less than about 100.

162. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise a fiber length/width ratio of greater than about 75.

163. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise a fiber length/width ratio of greater than about 50.

5 164. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers comprise a fiber length/width ratio of greater than about 40.

165. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a density less than about 0.6 g/cm^3 .

10 166. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a density less than about 0.4 g/cm^3 .

167. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a density less than about 0.2 g/cm^3 .

168. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a density less than about 0.15 g/cm^3 .

15 169. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a density less than about 0.1 g/cm^3 .

170. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a density greater than about 0.08 g/cm^3 .

20 171. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a density greater than about 0.04 g/cm^3 .

172. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a density greater than about 0.02 g/cm^3 .

173. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a bulk greater than about $1.67 \text{ cm}^3/\text{g}$.

25 174. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a bulk greater than about $2.0 \text{ cm}^3/\text{g}$.

175. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a bulk greater than about $5 \text{ cm}^3/\text{g}$.

176. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a bulk greater than about $10 \text{ cm}^3/\text{g}$.
177. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a bulk greater than about $15 \text{ cm}^3/\text{g}$.
- 5 178. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a bulk less than about $25 \text{ cm}^3/\text{g}$.
179. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a bulk less than about $75 \text{ cm}^3/\text{g}$.
180. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
10 comprising a bulk less than about $100 \text{ cm}^3/\text{g}$.
181. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a basis weight greater than about 10 g/m^2 .
182. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a basis weight greater than about 20 g/m^2 .
- 15 183. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a basis weight greater than about 30 g/m^2 .
184. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a basis weight greater than about 40 g/m^2 .
185. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
20 comprising a basis weight greater than about 50 g/m^2 .
186. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a basis weight less than about 60 g/m^2 .
187. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a basis weight less than about 75 g/m^2 .
- 25 188. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a basis weight less than about 100 g/m^2 .
189. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a lint value less than about 11.

190. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a lint value less than about 10.
191. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a lint value less than about 9.
- 5 192. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a lint value less than about 8.
193. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a lint value less than about 7.
194. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
10 comprising a lint value greater than about 4.
195. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a lint value greater than about 2.
196. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a lint value greater than about 0.5.
- 15 197. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a 2.5-160 micron PVD absorption greater than about 800 mg.
198. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a 2.5-160 micron PVD desorption greater than about 825 mg.
199. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
20 comprising a slip stick of less than about 964.
200. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, comprising a VFS greater than about 10 g/g.
201. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the web has a Runkel Ratio greater than about 3.
- 25 202. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the web has a Runkel Ratio greater than about 4.
203. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the web has a Runkel Ratio greater than about 5.

204. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the web has a Runkel Ratio greater than about 6.

205. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the web has a Runkel Ratio greater than about 7.

5 206. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the web has a Runkel Ratio less than about 8.

207. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the web has a Runkel Ratio less than about 9.

10 208. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the web has a Runkel Ratio less than about 10.

209. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fibers have a coarseness (according to the Coverage and Fiber Count Test Method) of less than about 22.4.

15 210. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a VFS from about 5.5 g/g to about 20 g/g.

211. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a VFS from about 5.5 g/g to about 10 g/g.

212. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a VFS from about 6 g/g to about 8 g/g.

20 213. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a HFS from about 4 g/g to about 30 g/g.

214. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a HFS from about 13 g/g to about 20 g/g.

25 215. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a HFS from about 14 g/g to about 18 g/g.

216. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a stack compressibility from about 25 mils/(log(g/in²)) to about 100 mils/(log(g/in²)).

217. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a stack compressibility from about 40 mils/(log(g/in²)) to about 60 mils/(log(g/in²)).

218. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a stack compressibility from about 45 mils/(log(g/in²)) to about 50 mils/(log(g/in²)).
219. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having an MD wet peak elongation from about 10% to about 30%.
- 5 220. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having an MD wet peak elongation from about 18% to about 25%.
221. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having an MD wet peak elongation from about 18% to about 22%.
222. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
10 having a CD wet peak elongation from about 5% to about 30%.
223. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD wet peak elongation from about 12% to about 20%.
224. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD wet peak elongation from about 12% to about 15%.
- 15 225. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having an MD wet peak TEA from about 15 g*in/in² to about 50 g*in/in².
226. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having an MD wet peak TEA from about 21 g*in/in² to about 35 g*in/in².
227. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
20 having an MD wet peak TEA from about 21 g*in/in² to about 26 g*in/in².
228. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD wet peak TEA from about 6 g*in/in² to about 40 g*in/in².
229. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD wet peak TEA from about 7 g*in/in² to about 20 g*in/in².
- 25 230. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD wet peak TEA from about 7 g*in/in² to about 15 g*in/in².
231. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD elongation (dry) from about 5% to about 25%.

232. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD elongation (dry) from about 12% to about 20%.
233. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD elongation (dry) from about 12% to about 15%.
- 5 234. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD TEA from about 5 in-g/in² to about 100 in-g/in².
235. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD TEA from about 32 in-g/in² to about 45 in-g/in².
236. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
10 having a CD TEA from about 32 in-g/in² to about 40 in-g/in².
237. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD modulus (dry) from about 200 g/cm to about 5000 g/cm.
238. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD modulus (dry) from about 3270 g/cm to about 4000 g/cm.
- 15 239. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a CD modulus (dry) from about 3270 g/cm to about 3500 g/cm.
240. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having an MD modulus (dry) from about 500 g/cm to about 6000 g/cm.
241. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2,
20 having an MD modulus (dry) from about 3360 g/cm to about 4000 g/cm.
242. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having an MD modulus (dry) from about 3360 g/cm to about 3600 g/cm.
243. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a dry burst (peak load) strength from about 250 g to about 1500 g.
- 25 244. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a dry burst (peak load) strength from about 400 g to about 1200 g.
245. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a dry burst (peak load) strength from about 600 g to about 1000 g.

246. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a wet burst strength to dry tensile ratio from about 0.05 to about 0.26.

247. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a wet burst strength to dry tensile ratio from about 0.15 to about 0.24.

5 248. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a wet burst strength to dry tensile ratio from about 0.18 to about 0.22.

249. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a wet burst strength to dry burst strength ratio from about 0.1 to about 0.50.

10 250. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a wet burst strength to dry burst strength ratio from about 0.2 to about 0.4.

251. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, having a wet burst strength to dry burst strength ratio from about 0.25 to about 0.35.

252. The sanitary tissue product of any of the preceding claims of Aspect 1 and this Aspect 2, wherein the short fiber content is Forestry Stewardship Council™ (FSC) certified.

15

Aspect 3 – Sanitary Tissue Process Claim Embodiments (Independent):

1. A process for making a sanitary tissue product, comprising:

forming a web comprising short fibers;

creating zones of differential densities in the web;

20 creping the web; and

forming the sanitary tissue product having at least about 70% short fibers and/or having a weight weighted mean fiber length of less than about 1.4.

2. A process for making a sanitary tissue product, comprising:

forming a web comprising at least about 80% short fibers;

25 creating knuckles and pillows in the web; and

creping the web.

3. A process for making a sanitary tissue product, comprising:

forming a web comprising at least about 80% short fibers;

30 transferring the web from a forming fabric to a transfer fabric, wherein a first speed delta is at least 10% between the forming fabric and the transfer fabric;

transferring the web from a transfer fabric to a TAD fabric, wherein a second speed delta is at least 10% between the transfer fabric and the TAD fabric; and

wherein the first speed delta (in fpm) is greater than the second speed delta.

4. A process for making a sanitary tissue product, comprising:

5 forming a web comprising at least about 80% short fibers;

transferring the web from a forming fabric to a transfer fabric, wherein a first speed delta is at least 10% between the forming fabric and the transfer fabric;

transferring the web from a transfer fabric to a TAD fabric, wherein a second speed delta is at least 10% between the transfer fabric and the TAD fabric; and

10 wherein the second speed delta (in fpm) is greater than the first speed delta.

5. A process for making a sanitary tissue product, comprising:

forming a web comprising at least about 80% short fibers;

transferring the web from a forming fabric to a transfer fabric, wherein a first speed delta is at least 10% between the forming fabric and the transfer fabric;

15 transferring the web from a transfer fabric to a TAD fabric, wherein a second speed delta is at least 10% between the transfer fabric and the TAD fabric; and

wherein the first and second speed deltas (in fpm) are substantially equal.

6. A process for making a sanitary tissue product, comprising:

forming a first layer of a web, the first layer comprising at least about 80% short fibers;

20 forming a second layer of a web, the first layer comprising at least about 80% short fibers;

using refined fibers to form first layer; and

using un-refined fibers to form the second layer.

7. A process for making a sanitary tissue product, comprising:

25 forming a first layer of a web using refined short fibers;

forming a second layer of a web using un-refined short fibers; and

forming a sanitary tissue product comprising the web, the sanitary tissue product comprising at least about 80% short fibers.

8. A process for making a sanitary tissue product, comprising:

30 forming a first layer of a web, the first layer comprising at least about 80% short fibers;

forming a second layer of a web, the first layer comprising at least about 80% short fibers;

applying strength chemistry to the first layer; and
keeping the second layer free from strength chemistry.

9. A process for making a sanitary tissue product, comprising:

forming a first layer of a web, the first layer comprising at least about 80% short fibers;

5 forming a second layer of a web, the first layer comprising at least about 80% short
fibers;

applying at least one of an enzyme and a biopolymer in at least one of the first and second
layers.

10. A process for making a sanitary tissue product, comprising:

10 forming a first layer of a web, the first layer comprising at least about 80% short fibers;

forming a second layer of a web, the first layer comprising at least about 80% short
fibers;

applying a biopolymer in the first layer; and

applying an enzyme in the second layer.

15

Aspect 4 – Sanitary Tissue Process Claim Embodiments (Dependent):

1. The process of according to the preceding claims of Aspect 3 and this Aspect 4, wherein a
speed of the forming, transfer, and TAD fabrics are from about 1000 fpm to about 3000 fpm.

2. The process of according to the preceding claims of Aspect 3 and this Aspect 4, wherein a
20 speed of the forming fabric is greater than 1000 fpm.

3. The process of according to the preceding claims of Aspect 3 and this Aspect 4, wherein a
speed of the transfer fabric is greater than 2000 fpm.

4. The process of according to the preceding claims of Aspect 3 and this Aspect 4, wherein a
speed of the TAD fabric is greater than 2000 fpm.

25 5. The process of according to the preceding claims of Aspect 3 and this Aspect 4, wherein a
speed of the forming fabric is from about 2000 fpm to about 2500 fpm.

6. The process of according to the preceding claims of Aspect 3 and this Aspect 4, wherein a
speed of the transfer fabric is from about 2000 fpm to about 2500 fpm.

30 7. The process of according to the preceding claims of Aspect 3 and this Aspect 4, wherein a
speed of the TAD fabric is from about 2000 fpm to about 2500 fpm.

8. The process of according to the preceding claims of Aspect 3 and this Aspect 4, further comprising the step of transferring the web to a Yankee.

Aspect 5 – Claim Embodiments comprising arrays comprising short fibers:

- 5 1. An array of sanitary tissue products, comprising:
 - a first sanitary tissue product in a first package that conveys strength, absorption, and/or softness;
 - a second sanitary tissue product in a second package that conveys sustainability;
 - wherein TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST are common intensive
 - 10 properties of the first and second sanitary tissue products;
 - wherein at least one of TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST of the first sanitary tissue product is at least 5% different than, but within 25% of, the TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST, respectively, of the second sanitary tissue product;
 - wherein the second sanitary tissue product comprises at least about 70% short fibers
 - 15 and/or has a weight weighted mean fiber length of less than about 1.4;
 - wherein the first and second sanitary tissue product packages are separate from and adjacent to each other;
 - wherein each of the first and second sanitary tissue product packages comprise a common single source identifier; and
 - 20 wherein the first and second sanitary tissue product packages comprise different sub-brand name portions.
2. The array of sanitary tissue products of claim 1, wherein the first package conveys strength, and wherein the tensile ratio of the first sanitary tissue product is at least 5% different than, but within 15% of, the tensile ratio of the second sanitary tissue product.
- 25 3. The array of sanitary tissue products according to any of the preceding claims, wherein the tensile ratio of the first sanitary tissue product is less than about 1.7.
4. The array of sanitary tissue products of according to any of the preceding claims, wherein the first package conveys softness, and wherein at least one of TS7, TS750, lint, and slip stick of the first sanitary tissue product is at least 5% different than, but within 15% of, the TS7, TS750, and
- 30 slip stick, respectively, of the second sanitary tissue product.
5. The array of sanitary tissue products according to any of the preceding claims, wherein the TS7 of the first sanitary tissue product is less than about 14 dB V² rms.

6. The array of sanitary tissue products according to any of the preceding claims, wherein the TS750 of the first sanitary tissue product is less than about 20 dB V² rms.
7. The array of sanitary tissue products according to any of the preceding claims, wherein the slip stick of the first sanitary tissue product is less than about 435 dB V² rms.
- 5 8. The array of sanitary tissue products according to any of the preceding claims, wherein the lint of the first sanitary tissue product is greater than about 6.
9. The array of sanitary tissue products of according to any of the preceding claims, wherein the first package conveys absorption, wherein at least one of VFS and SST of the first sanitary tissue product is at least 5% different than, but within 15% of, the VFS and SST, respectively, of the
- 10 10. The array of sanitary tissue products according to any of the preceding claims, wherein the second sanitary tissue product, and wherein the sanitary tissue product is in the form of a paper towel.
10. The array of sanitary tissue products according to any of the preceding claims, wherein the VFS of the first sanitary tissue product is greater than about 7.3 g/g.
11. The array of sanitary tissue products according to any of the preceding claims, wherein the
- 15 11. The array of sanitary tissue products according to any of the preceding claims, wherein the SST of the first sanitary tissue product is greater than about 0.45 g/s^{0.5}.
12. The array of sanitary tissue products according to any of the preceding claims, wherein the short fibers are selected from the group consisting of Acacia, Eucalyptus, Bagasse, Maple, Oak, Aspen, Birch, Cottonwood, Alder, Ash, Cherry, Elm, Hickory, Poplar, Gum, Walnut, Locust, Sycamore, Beech, Catalpa, Sassafras, Gmelina, Albizia, Anthocephalus, Magnolia, and
- 20 12. The array of sanitary tissue products according to any of the preceding claims, wherein the combinations thereof.
13. The array of sanitary tissue products according to any of the preceding claims, wherein the first sanitary tissue product consists of short fibers.
14. The array of sanitary tissue products according to any of claims 1-12, wherein the first sanitary tissue product comprises short fibers.
- 25 15. The array of sanitary tissue products according to any of claims 1-12 and 14, wherein the short fibers of the first and second sanitary tissue products are different fiber types.
16. The array of sanitary tissue products according to any of the preceding claims, wherein the second sanitary tissue product comprises a greater content of short fibers by weight.

17. The array of sanitary tissue products according to any of claims 1-12 and 14-16, wherein the short fiber content of the first sanitary tissue product is at least 10% greater by weight than the short fiber content of the first sanitary tissue product.
18. The array of sanitary tissue products according to any of claims 1-12 and 14-16, wherein the
5 short fiber content of the first sanitary tissue product is at least 30% greater by weight than the short fiber content of the first sanitary tissue product.
19. The array of sanitary tissue products according to any of claims 1-12 and 14-18, wherein the first sanitary tissue product comprises eucalyptus and wherein the second sanitary tissue product comprises bagasse.
- 10 20. The array of sanitary tissue products according to any of the preceding claims, wherein the first and second packages are immediately adjacent to each other on a shelf.

Aspect 6— Claim embodiments comprising arrays comprising short fibers:

1. An array of sanitary tissue products comprising:
- 15 a first sanitary tissue product in a first package that conveys strength, absorption, and/or softness, wherein the first package comprises a plastic film in contact with the first sanitary tissue product;
- a second sanitary tissue product in a second package that conveys sustainability, wherein the second package comprises a sustainable package material in contact with the second sanitary
20 tissue product;
- wherein the second sanitary tissue product comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4 and has a greater short fiber content than the first sanitary tissue product;
- wherein TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST are common intensive
25 properties of the first and second sanitary tissue products;
- wherein at least one of TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST of the first sanitary tissue product is at least 5% different than, but within 25% of, the TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST, respectively, of the second sanitary tissue product;
- wherein the first and second sanitary tissue product packages are separate from and
30 adjacent to each other;
- wherein each of the first and second sanitary tissue product packages comprise a common single source identifier; and

wherein the first and second sanitary tissue product packages comprise different sub-brand name portions.

2. The array of sanitary tissue products of claim 1, wherein the second package does not comprise a plastic film.

5 3. The array of sanitary tissue products of claim 1, wherein the sustainable package material is selected from the group consisting of paper, recycled plastic, plant-based plastic, recycled paper, cardboard, and combinations thereof.

4. The array of sanitary tissue products according to any of claims 1 and 2, wherein the sustainable package material is a paper-based material, and wherein an inner surface of the paper-based material is a different color than an outside surface of the paper-based material.

10 5. The array of sanitary tissue products according to any of the preceding claims, wherein the short fibers are selected from the group consisting of Acacia, Eucalyptus, Bagasse, Maple, Oak, Aspen, Birch, Cottonwood, Alder, Ash, Cherry, Elm, Hickory, Poplar, Gum, Walnut, Locust, Sycamore, Beech, Catalpa, Sassafras, Gmelina, Albizia, Anthocephalus, Magnolia, and combinations thereof.

15 6. The array of sanitary tissue products according to any of the preceding claims, wherein the first sanitary tissue product consists of short fibers.

7. The array of sanitary tissue products according to any of claims 1-5, wherein the first sanitary tissue product comprises short fibers.

20 8. The array of sanitary tissue products according to any of claims 1-5 and 7, wherein the short fibers of the first and second sanitary tissue products are different short fiber types.

9. The array of sanitary tissue products according to any of claims 1-5 and 7-8, wherein the short fiber content of the second sanitary tissue product is at least 30% greater by weight than the short fiber content of the first sanitary tissue product.

25 10. The array of sanitary tissue products according to any of claims 1-5 and 7-9, wherein the first sanitary tissue product comprises eucalyptus and wherein the second sanitary tissue product comprises trichomes.

11. The array of sanitary tissue products according to any of the preceding claims, wherein the first and second packages are immediately adjacent to each other on a shelf.

12. The array of sanitary tissue products according to any of the preceding claims, wherein the first and second packages are on a pallet.

13. A packaged sanitary tissue product, comprising:

a package, comprising:

- 5 a sustainable package material;
 a brand name;
 wherein the package conveys sustainability;
 indicia representative of at least portions of plants and/or trees overlapping indicia
 representative of the sanitary tissue product; and
10 a sanitary tissue product comprising at least about 70% short fibers and/or has a
 weight weighted mean fiber length of less than about 1.4, the sanitary tissue product being
 in direct contact with the sustainable package material.

14. The packaged sanitary tissue product of claim 13, wherein the sustainable package material is
selected from the group consisting of paper, recycled plastic, plant-based plastic, recycled paper,
15 cardboard, and combinations thereof.

15. The packaged sanitary tissue product of claim 13, wherein the sustainable package material
and the sanitary tissue product comprise the same short fiber types.

16. The packaged sanitary tissue product of claim 13, wherein the sustainable package material
and the sanitary tissue product comprise different short fiber types.

20 17. The packaged sanitary tissue product according to any of claims 13-16, wherein the sustainable
package material comprises wood fibers.

18. The packaged sanitary tissue product according to any of claims 13-17, wherein the sustainable
package material comprises an exterior surface of a first color and an interior surface of a
contrasting color to the first color.

25 19. The packaged sanitary tissue product according to any of claims 13 and 15-18, wherein the
sustainable package material is paper-based.

20. The packaged sanitary tissue product according to any of claims 13-19, wherein the indicia
representative of the sanitary tissue product comprises side edges, and wherein the indicia
representative of at least portions of plants and/or trees overlaps the side edges.

30 21. The packaged sanitary tissue product according to any of claims 13-20, wherein the short fibers
are selected from the group of eucalyptus, bagasse, trichomes, and mixtures thereof.

22. The packaged sanitary tissue product according to any of claims 13-21, wherein the exterior color is brown or tan and wherein the interior surface is white.

23. The packaged sanitary tissue product according to any of claims 13-22, wherein the sustainable package material is cardboard.

5 24. The packaged sanitary tissue product according to any of claims 13-23, wherein the package comprises a sub-brand name.

Aspect 7- Claim Embodiments comprising Arrays of Sanitary Tissue Products

1. An array of sanitary tissue products comprising:

10 a first sanitary tissue product in a first package that conveys strength and/or softness, the first package disposed on a retail store shelf;

a digital image representative of a second package that conveys sustainability, and that is representative of a second sanitary tissue product for sale, the second sanitary tissue product disposed at a location other than the retail store shelf;

15 wherein TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST are common intensive properties of the first and second sanitary tissue products;

wherein at least one of TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST of the first sanitary tissue product is at least 5% different than, but within 25% of, the TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST, respectively, of the second sanitary tissue product;

20 wherein the second sanitary tissue product comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4 and has a greater short fiber content than the first sanitary tissue product;

wherein each of the first and second sanitary tissue product packages comprise a common single source identifier; and

25 wherein the first and second sanitary tissue product packages comprise different sub-brand name portions.

2. The array of sanitary tissue products of claim 1, wherein the second package does not comprise a plastic film.

3. The array of sanitary tissue products of claim 1, wherein the second package comprises
30 material selected from the group consisting of paper, recycled plastic, plant-based plastic, recycled paper, cardboard, and combinations thereof.

4. The array of sanitary tissue products according to any of the preceding claims, wherein the second package comprises a paper-based material, and wherein an inner surface of the second package is a different color than an outside surface of the second package.
5. The array of sanitary tissue products according to any of the preceding claims, wherein the short
5 fibers are selected from the group consisting of Acacia, Eucalyptus, Bagasse, Maple, Oak, Aspen, Birch, Cottonwood, Alder, Ash, Cherry, Elm, Hickory, Poplar, Gum, Walnut, Locust, Sycamore, Beech, Catalpa, Sassafras, Gmelina, Albizia, Anthocephalus, Magnolia, and combinations thereof.
6. The array of sanitary tissue products according to any of the preceding claims, wherein the first sanitary tissue product consists of wood fibers.
- 10 7. The array of sanitary tissue products according to any of claims 1-5, wherein the first sanitary tissue product comprises short fibers.
8. The array of sanitary tissue products according to any of the preceding claims, wherein the second sanitary tissue product is located on a pallet.
9. The array of sanitary tissue products according to any of the preceding claims, wherein the
15 second sanitary tissue product is located in a warehouse.
10. The array of sanitary tissue products according to any of the preceding claims, wherein the first package comprises a plastic film.
11. The array of sanitary tissue products of claim 10, wherein the plastic film is not recycled.
12. An array of sanitary tissue products comprising:
20 a first digital image representative of a first package that conveys strength and/or softness, and that is representative of a first sanitary tissue product;
a second digital image representative of a second package that conveys sustainability, and that is representative of a second sanitary tissue product;
wherein TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST are common intensive
25 properties of the first and second sanitary tissue products;
wherein at least one of TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST of the first sanitary tissue product is at least 5% different than, but within 25% of, the TS7, TS750, lint, slip stick, tensile ratio, VFS, and SST, respectively, of the second sanitary tissue product;
wherein the second sanitary tissue product comprises at least about 70% short fibers
30 and/or has a weight weighted mean fiber length of less than about 1.4 and has a greater short fiber content than the first sanitary tissue product;

wherein the first and second digital images representative of first and second packages are made to appear separate from each other;

wherein each of the first and second digital images and the corresponding first and second sanitary tissue product packages comprise a common single source identifier; and

5 wherein the first and second digital images and the corresponding first and second sanitary tissue product packages comprise different sub-brand name portions.

13. The array of sanitary tissue products of claim 12, wherein the first package is disposed on a retail shelf and wherein the second package is disposed in a warehouse.

14. The array of sanitary tissue products according to any of claims 12 and 13, wherein the first
10 package is available for purchase at a plurality of websites and wherein the second package is available for sale at a website that is not part of the plurality of websites.

15. The array of sanitary tissue products according to any of claims 12-14, wherein the second package does not comprise a plastic film.

16. The array of sanitary tissue products according to any of claims 12-14, wherein the second
15 package comprises material selected from the group consisting of paper, recycled plastic, plant-based plastic, recycled paper, cardboard, and combinations thereof.

17. The array of sanitary tissue products according to any of claims 12-16, wherein the second package comprises a paper-based material, and wherein an inner surface of the second package is a different color than an outside surface of the second package.

20 18. The array of sanitary tissue products of claim 12-17, wherein the short fibers are selected from the group consisting of Acacia, Eucalyptus, Bagasse, Maple, Oak, Aspen, Birch, Cottonwood, Alder, Ash, Cherry, Elm, Hickory, Poplar, Gum, Walnut, Locust, Sycamore, Beech, Catalpa, Sassafras, Gmelina, Albizia, Anthocephalus, Magnolia, and combinations thereof.

19. The array of sanitary tissue products according to any of claims 12-18, wherein the first sanitary
25 tissue product consists of short fibers.

20. The array of sanitary tissue products according to any of claims 12-18, wherein the first sanitary tissue product comprises short fibers.

21. The array of sanitary tissue products according to any of claims 12-20, wherein the second package is located on a pallet.

22. The array of sanitary tissue products according to any of claims 12-21, wherein the first package comprises a plastic film.

Aspect 8— Claim embodiments comprising arrays comprising short fibers:

- 5 1. An array of sanitary tissue products, comprising:
- a first sanitary tissue product in a first package that conveys strength;
 - a second sanitary tissue product in a second package that conveys softness;
 - a third sanitary tissue product in a third package that conveys strength;
 - a fourth sanitary tissue product in a fourth package that conveys softness;
- 10 wherein TS7, TS750, lint, slip stick, and tensile ratio are common intensive properties of the first, second, third, and fourth sanitary tissue products;
- wherein at least one of TS7, TS750, lint, slip stick, and tensile ratio of the first sanitary tissue product is at least 5% different than, but within 25% of, the TS7, TS750, lint, slip stick, and tensile ratio, respectively, of the second sanitary tissue product;
- 15 wherein at least one of TS7, TS750, lint, slip stick, and tensile ratio of the third sanitary tissue product is at least 5% different than, but within 25% of, the TS7, TS750, lint, slip stick, and tensile ratio, respectively, of the fourth sanitary tissue product;
- wherein the first sanitary tissue product is a higher tier than the third sanitary tissue product as the first sanitary tissue product has a less positive, but within 25% of, tensile ratio than
- 20 the third sanitary tissue product;
- wherein the second sanitary tissue product is a higher tier than the fourth sanitary tissue product, wherein the second sanitary tissue product has at least one of a less positive, but within 25% of, TS7, TS750, and slip stick value than the fourth tissue product, and/or wherein the second sanitary tissue product has a more positive, but within 25% of, lint value than the fourth
- 25 sanitary tissue product;
- wherein at least one of the first and second sanitary tissue products comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4;
 - wherein the first sanitary tissue product has a greater short fiber content than the third sanitary tissue product and/or wherein the second sanitary tissue product has a greater short fiber
- 30 content than the fourth sanitary tissue product;
- wherein the first, second, third, and fourth sanitary tissue product packages are separate from and adjacent to each other; and

wherein each of the first, second, third, and fourth sanitary tissue product packages each comprise a common single source identifier.

2. The array of sanitary tissue products of claim 1, wherein the first, second, third, and fourth sanitary tissue products are in the form of toilet paper.

5 3. The array of sanitary tissue products according any of the preceding claims, wherein the tensile ratio of the first sanitary tissue product is less than about 1.7.

4. The array of sanitary tissue products according any of the preceding claims, wherein the TS7 of the second sanitary tissue product is less than about 14 dB V² rms.

10 5. The array of sanitary tissue products according any of the preceding claims, wherein the TS750 of the second sanitary tissue product is less than about 20 dB V² rms.

6. The array of sanitary tissue products according any of the preceding claims, wherein the slip stick of the second sanitary tissue product is less than about 435 dB V² rms.

7. The array of sanitary tissue products according any of the preceding claims, wherein the lint of the second sanitary tissue product is greater than about 6.

15 8. The array of sanitary tissue products according any of the preceding claims, wherein the first and second sanitary tissue products convey sustainability.

9. The array of sanitary tissue products according any of the preceding claims, wherein the third and fourth sanitary tissue products convey sustainability.

20 10. The array of sanitary tissue products according any of the preceding claims, wherein the first and third sanitary tissue products do not convey softness.

11. The array of sanitary tissue products according any of the preceding claims, wherein the second and fourth sanitary tissue products do not convey strength.

25 12. The array of sanitary tissue products according any of the preceding claims, wherein the short fibers of the first and second sanitary tissue products are selected from the group consisting of eucalyptus, bagasse, trichomes, and combinations thereof.

13. The array of sanitary tissue products according any of the preceding claims, wherein the third and/or the fourth sanitary tissue products consist of short fibers.

14. The array of sanitary tissue products according any of the preceding claims, wherein the first and/or the second sanitary tissue products comprise wood fibers.

15. The array of sanitary tissue products according any of the preceding claims, wherein the short fibers of the first and second sanitary tissue products are different short fiber types.

16. The array of sanitary tissue products according any of the preceding claims, wherein the second sanitary tissue product comprises a greater content of short fibers by weight than the first sanitary
5 tissue product.

17. The array of sanitary tissue according any of the preceding claims, wherein the first sanitary tissue product comprises eucalyptus and wherein the second sanitary tissue product comprises bagasse.

18. The array of sanitary tissue products according any of the preceding claims, wherein the third
10 and fourth sanitary tissue product packages comprise common sub-brand name portions.

19. An array of sanitary tissue products, comprising:

a first sanitary tissue product, in the form of a paper towel, in a first package that conveys sustainability;

a second sanitary tissue product, in the form of a paper towel, in a second package that
15 conveys strength and/or absorbency;

wherein VFS and SST are common intensive properties of the first and second sanitary tissue products;

wherein the first sanitary tissue product is a higher tier than the second sanitary tissue product as the first sanitary tissue product has at least one of a more positive, but within 25% of,
20 VFS and SST than the second sanitary tissue product;

wherein the first sanitary tissue product comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4;

wherein the first sanitary tissue product has a greater short fiber content than the second sanitary tissue product;

25 wherein the first and second sanitary tissue product packages are separate from and adjacent to each other; and

wherein each of the first and second sanitary tissue product packages comprise a common single source identifier.

20. The array of sanitary tissue products of claim 19, wherein the VFS of the first sanitary tissue
30 product is greater than about 7.3 g/g.

21. The array of sanitary tissue products according any of claims 19 and 20, wherein the SST of the first sanitary tissue product is greater than about $0.45 \text{ g/s}^{0.5}$.

22. The array of sanitary tissue products according any of claims 19-21, wherein the first and second sanitary tissue product packages comprise different sub-brand name portions.

Aspect 9 – Claim embodiments comprising arrays comprising short fibers

- 5 1. An array of sanitary tissue products, comprising:
- a first sanitary tissue product in a first package, wherein the first sanitary tissue product comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4;
 - a second sanitary tissue product in a second package, wherein the second sanitary tissue
10 product comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4;
 - wherein the first and second sanitary tissue product packages are separate from and adjacent to each other;
 - wherein each of the first and second sanitary tissue product packages comprise a common
15 single source identifier;
 - wherein the first and second sanitary tissue product packages comprise different sub-brand name portions;
 - wherein the first sanitary tissue product is selected from the group of product forms consisting of toilet paper, paper towels, and facial tissue;
 - 20 wherein the second sanitary tissue product is selected from the group of product forms consisting of toilet paper, paper towels, and facial tissue; and
 - wherein the first and second sanitary tissue products are different product forms.
2. The array of claim 1, further comprising a third sanitary tissue product in a third package, wherein the third sanitary tissue product comprises at least about 70% short fibers and/or has a
25 weight weighted mean fiber length of less than about 1.4, and wherein the first sanitary tissue product is toilet tissue, the second sanitary tissue product is a paper towel, and the third sanitary tissue product is facial tissue.

Aspect 10– Claim embodiments comprising arrays comprising short fibers:

- 30 1. An array of sanitary tissue products, comprising:

a first sanitary tissue product in a first package, wherein the first sanitary tissue product comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4;

5 a second sanitary tissue product in a second package, wherein the second sanitary tissue product comprises long fibers;

wherein the first and second sanitary tissue product packages are separate from and adjacent to each other;

wherein each of the first and second sanitary tissue product packages comprise a common single source identifier;

10 wherein the first and second sanitary tissue product packages comprise different sub-brand name portions;

wherein the first sanitary tissue product is selected from the group of product forms consisting of toilet paper, paper towels, and facial tissue;

15 wherein the second sanitary tissue product is selected from the group of product forms consisting of toilet paper, paper towels, and facial tissue; and

wherein the first and second sanitary tissue products are the same product forms.

2. The array of claim 1, wherein the first and second sanitary tissue products are toilet tissues.

3. The array of claim 1, wherein the first and second sanitary tissue products are paper towels.

4. The array of claim 1, wherein the first and second sanitary tissue products are facial tissues.

20

Aspect 11 – Claim embodiments comprising arrays comprising short fibers:

1. An array of sanitary tissue products, comprising:

25 a first sanitary tissue product in a first package, wherein the first sanitary tissue product comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4;

a second sanitary tissue product in a second package, wherein the second sanitary tissue product comprises at least about 70% short fibers and/or has a weight weighted mean fiber length of less than about 1.4;

30 wherein the first and second sanitary tissue product packages are separate from and adjacent to each other;

wherein each of the first and second sanitary tissue product packages comprise a common single source identifier;

wherein the first and second sanitary tissue product packages comprise different sub-brand name portions;

wherein the first sanitary tissue product is selected from the group of product forms consisting of toilet paper, paper towels, and facial tissue;

5 wherein the second sanitary tissue product is selected from the group of product forms consisting of toilet paper, paper towels, and facial tissue;

wherein the first and second sanitary tissue products are the same product forms; and

wherein the first sanitary tissue product has a higher TDT than the second sanitary tissue product.

10 2. The array of claim 1, wherein the first sanitary tissue product conveys strength.

3. The array of claim 2, wherein the second sanitary tissue product conveys softness.

TEST METHODS OF THE PRESENT DISCLOSURE

15 Unless otherwise specified, all tests described herein including those described under the Definitions section and the following test methods are conducted on samples that have been conditioned in a conditioned room at a temperature of $23^{\circ}\text{C} \pm 1.0^{\circ}\text{C}$ and a relative humidity of $50\% \pm 2\%$ for a minimum of 2 hours prior to the test. The samples tested are “usable units.” “Usable units” as used herein means sheets, flats from roll stock, pre-converted flats, and/or single or multiply products. All tests are conducted in such conditioned room. Do not test samples that have
20 defects such as wrinkles, tears, holes, and like. All instruments are calibrated according to manufacturer’s specifications.

Percent Short Fiber Mass Inclusion (also referred to as “% Short Fiber Inclusion” – see FIG. 18-1) Method

25 TAPPI/ANSI T401 can be used to inform the percent of short fibers (consistent with meaning of short fibers in the present disclosure) by weight in a sanitary tissue product. For clarity, consistent with TAPPI/ANSI T401, all references to short fiber inclusion in the present disclosure are by weight.

Perforation (Perf) Tensile Strength Test Method

30 Perf elongation, perf tensile strength, perf TEA and perf tangent modulus for this Perforation Tensile Strength Test Method are measured by or calculated from data generated by a

constant rate of extension tensile tester with computer interface (a suitable instrument is the EJA Vantage from the Thwing-Albert Instrument Co. West Berlin, N.J.) using a load cell for which the forces measured are within 10% to 90% of the limit of the load cell. Both the movable (upper) and stationary (lower) pneumatic jaws are fitted with smooth stainless steel faced grips, with a design suitable for testing the full width of one sheet material. For example, the Thwing-Albert item #734K grips are suitable for testing a sheet having about a four inch width. An air pressure of about 60 psi is supplied to the jaws.

Samples for this Perforation Tensile Strength Test Method are conditioned in a conditioned room at a temperature of $73^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 1^{\circ}\text{C}$) and a relative humidity of 50% ($\pm 2\%$) for 2 hours prior to the test. All plastic and paper board packaging materials are carefully removed from the paper samples prior to testing. If the sample is in roll form, remove at least the leading five sheets by unwinding and tearing off via the closest line of weakness, and discard before testing the sample. Do not test sheet samples with defects such as perforation skips, wrinkles, tears, incomplete perforations, holes, etc.

A full finished product width sheet sample of a paper towel or bath tissue product is cut so that a perforation line passes across the sheet parallel to each cut in the width dimension. More specifically, take two adjacent sheets separated by a line of weakness (comprising one or more perforations), and cut a test sample to include at least a portion of the two tissue sheets. The cuts should be made across the width of the sheet generally parallel to the line of perforation and equally about the line of perforation. For example, the first cut is made at least two inches above the line of weakness comprising perforations and another cut is made on the other side of the line of weakness at least two inches from the line of weakness comprising perforations. At all times the sample should be handled in such a manner that perforations are not damaged or weakened. The prepared sample is placed in the grips so that no part of the line of weakness is touching or inside the clamped grip faces. Further, the line of weakness should be generally parallel to the grip. Stated another way, if an imaginary line were drawn across the width of the sheet connecting the two points at which the line of weakness crosses the edge of the sheet, the imaginary line should be generally parallel to the longitudinal axis of the grips (i.e., perpendicular to the direction of elongation).

Program the tensile tester to perform an extension test, collecting force and extension data at an acquisition rate of 20 Hz as the crosshead raises at a rate of 4.00 in/min (10.16 cm/min) until the specimen breaks (i.e., when the test specimen is physically separated into two parts).

The break sensitivity is set to 98%, i.e., the test is terminated when the measured force drops to $\leq 2\%$ of the maximum peak force, after which the crosshead is returned to its original position.

Set the gage length to 2.0 inches. Zero the crosshead position and load cell. Insert the sheet sample into the upper and lower open grips such that at least 0.5 inches of sheet length is contained each grip. Verify sheet sample is properly aligned, as previously discussed, and then close lower and upper grips. The sheet sample should be under enough tension to eliminate any slack, but less than 5 g of force measured on the load cell. Start the tensile tester and data collection.

The location of failure (break) should be the line of weakness. Each sample sheet should break completely at the line of weakness. The peak force to tear the line of weakness is reported in grams. If the location of the failure (break) is not the line of weakness, disregard the data and repeat the test with another sheet sample. Note, the output result is for the entire sheet sample and therefore does not need to be normalized.

Adjusted Gage Length is calculated as the extension measured at 5 g of force (in) added to the original gage length (in).

Peak Tensile is calculated as the force at the maximum or peak force. The result is reported in units of g/in, to the nearest 1 g/in. Note the output results are for the entire sheet sample width and is not normalized.

Failure Total Energy Absorption (Fail_TEA) is calculated as the area under the force curve integrated from zero extension to the extension at the "failure" point (g*in), divided by the adjusted Gage Length (in). The failure point is defined here as the extension when the tension force falls to 5% of the maximum peak force. This is reported with units of g*in/in to the nearest 1 g*in/in. Again, note that the output results are for the entire sheet sample width.

Repeat the above mentioned steps for each sample sheet. Four sample sheets should be tested and the results from those four tests should be averaged to determine a reportable data point.

Coverage, Fiber Count-Area, and Weight Weighted Mean Fiber Length Test Methods:

Coverage and Fiber Count are calculated using measurements acquired by analyzing fibers obtained from fibrous structures, such as sanitary tissue products, with a Fiber Quality Analyzer (FQA), available from OpTest Equipment Inc., Ontario, Canada. Prior to analysis in the FQA fibers from a finished product specimen must be dispersed and diluted to get an accurate measurement of the oven dry fiber mass in an aliquot of very dilute fiber and distilled water,

which is utilized during the FQA analysis to determine specimen coarseness and fiber width. The resultant FQA values, in conjunction with basis weight, are then used to calculate fiber coverage and fiber count in a specimen.

5 Sample Preparation

Allow the fibrous structure finished product to be tested to equilibrate in a temperature-controlled room at a temperature of $73^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 1^{\circ}\text{C}$) and a relative humidity of $50\% \pm 2\%$ for at least 24 hours. Further prepare the finished product for testing by removing and discarding any product which might have been abraded in handling, e.g., on the outside of the
10 roll.

Determine the percent oven dry solids of the equilibrated test product. This is done on a moisture balance using least a 0.5 gram specimen from a selected usable unit of the test product. An exemplary balance is the Ohaus MB45 balance set to a drying temperature of 130°C , with moisture determined after the weight changes less than 1mg in 60 seconds (A60 hold time).

15 Using another usable unit from the same equilibrated finished product, gently pull approximately 0.03 grams of fiber specimen from the center. The specimen should be equally pulled from all plies and layers of the substrate. Place the collected fibers into a 27mm diameter, 70mm tall clear glass vial, or similar. Record the net weight of collected fibers to the nearest 0.001 gram as M_0 . The intent of this step is to get an even sampling across all plies and layers in
20 the usable unit, pulled from the center of the usable unit so that no cutting of fibers at the end of the sheet or perforations is included.

The oven dry weight of the fiber specimen (M_1) is then calculated by multiplying the fiber specimen weight (M_0) by the previously determined percent oven dry solids.

$$M_1 = M_0 \times \% \text{ oven dry solids}$$

25 To fully disperse the fiber specimen, begin by adding approximately 3.5 grams of bleach (NaOCl , 5% as Cl) and 10.5 grams of DI or distilled water into the vial until approximately $\frac{1}{2}$ full, adding about ten 5mm diameter glass beads, and then closing the vial with a cap. The final bleach solution should be approximately 1.25% as Cl. Next, allow the specimen to sit for at least two hours with occasional shaking. Lastly, stir the vial with a Fisher Scientific vortex genie,
30 or similar, until fiber clusters are dispersed, and the fibers appear fully individualized.

To quantitatively dilute the dispersed fiber sample, begin by transferring the entire vial contents into a 5L plastic beaker that has been weighed to the nearest 0.1g. To accomplish this,

slowly pour the contents of vial through a #6 US Standard Sieve (3.35mm), trying to keep the glass beads in the vial as long as possible. Then rinse the vial and cap at least three times with DI or distilled water and continue to pour the liquid slowly through the #6 sieve. Once the vial has been at least triple rinsed, pour the glass beads into the sieve and wash thoroughly with a DI water squeeze bottle, being sure to collect all water used to rinse the beads.

Continue with the dilution procedure by filling the 5L plastic beaker to approximately the 1.75L mark with DI or distilled water. Weigh the beaker and record the net weight of the contents to the nearest 0.1g as $M_{2.1}$. Using a second clean 5L beaker, transfer the 1.75L of solution back and forth at least 3 times from beaker to beaker to ensure that the suspension is homogenously mixed. Next, transfer approximately 150g of the solution into a third clean 5L beaker that has been weighed to the nearest 0.1g. Weigh the beaker and record the net weight of the contents to the nearest 0.1g as $M_{2.2}$. Then add approximately 1600g of DI or distilled water to the third 5L beaker. Weigh the beaker and record the net weight of the contents to the nearest 0.1g as $M_{2.3}$. With a fourth clean 5L beaker, transfer the approximately 1.75L of solution back and forth at least 3 times from beaker to beaker to ensure that the suspension is homogenously mixed. Lastly, immediately after mixing, pour a 500mL aliquot of the diluted fiber solution into a 600mL plastic beaker that has been weighed to the nearest 0.1g. Weigh the beaker and record the net weight of the contents to the nearest 0.1g as M_3 .

Upon completion of the dilution procedure, calculate the oven dry weight of fibers present in the testing beaker (M_4) according to the following equation:

$$M_4 = M_1 \times \left(\frac{M_{2.2}}{M_{2.1}} \right) \times \left(\frac{M_3}{M_{2.3}} \right)$$

Measurement of samples

Set up, calibrate, and operate the Fiber Quality Analyzer (FQA) instrument according to the manufacturer's instructions. Place the beaker containing the diluted fiber suspension on carrousel of the FQA, select the "Optest default" for coarseness method, and when prompted, enter M_4 (the oven dry weight of fibers present in the testing beaker) in the cell for "sample mass" to determine coarseness.

Calculations

Once the analysis has been performed, open the report file and record each of the following measurements: Arithmetic Mean Width, Coarseness, Arithmetic Mean Length, Length Weighted Mean Length, and Weight Weighted Mean Length.

Calculate Coverage, which has the units of fiber layers, using the following equation:

$$\text{Coverage} = \frac{\text{Basis Weight of product tested}}{\frac{\text{Coarseness}}{\text{Arithmetic mean width}}}$$

Where basis weight has units of grams/m², Coarseness has units of mg/m, and Arithmetic Mean Width has the units of mm.

- 5 Calculate Fiber Count-Area, which has the units of millions fibers/m², using one of these two equations:

$$\text{Fiber Count} - \text{Area } (C(n)) = \frac{\text{Basis Weight of product tested}}{\text{Coarseness} \times \text{Arithmetic Mean Length}}$$

Where basis weight has the units of g/m², Coarseness has the units of mg/m, and Arithmetic Mean Length has the units of mm.

10
$$\text{Fiber Count} - \text{Area } (C(l)) = \frac{\text{Basis Weight of product tested}}{\text{Coarseness} \times \text{Length Weighted Mean Length}}$$

Where basis weight has the units of g/m², Coarseness has the units of mg/m, and Length Weighted Mean Length has the units of mm.

Pore Volume Distribution Test Method:

- 15 The Pore Volume Distribution (PVD) Test Method is used to determine the average amount of fluid (mg) retained by a specimen within an effective pore radius range of 2.5 to 160 microns. This method makes use of stepped, controlled differential pressure and measurement of associated fluid movement into and out of a porous specimen, where the radius of a pore is related to the differential pressure required to fill or empty the pore. The fluid retained (mg) by each specimen during its first absorption cycle of decreasing differential pressures is measured, this is followed by measurement of fluid retained (mg) by the specimen during its first drainage or desorption cycle of increasing differential pressures. The sum of fluid retained (mg) by the specimen within the effective pore radius range of 2.5 to 160 microns for the absorption and desorption cycles, as well as a calculated hysteresis (difference of fluid retained during the absorption and desorption cycles) in the effective pore radius range of 2.5 to 100 microns are reported.
- 20
- 25

Method principle

For uniform cylindrical pores, the radius of a pore is related to the differential pressure required to fill or empty the pore by the equation

- 30 Differential pressure = $(2 \gamma \cos \Theta) / r$,

where γ = liquid surface tension, Θ = contact angle, and r = effective pore radius.

Pores contained in natural and manufactured porous materials are often thought of in terms such as voids, holes or conduits, and these pores are generally not perfectly cylindrical nor all uniform. One can nonetheless use the above equation to relate differential pressure to an effective pore radius, and by monitoring liquid movement into or out of the material as a function of differential pressure characterize the effective pore radius distribution in a porous material. (Because nonuniform pores are approximated as uniform by the use of an effective pore radius, this general methodology may not produce results precisely in agreement with measurements of void dimensions obtained by other methods such as microscopy.)

The Pore Volume Distribution Test Method uses the above principle and is reduced to practice using the apparatus and approach described in "Liquid Porosimetry: New Methodology and Applications" by B. Miller and I. Tyomkin published in The Journal of Colloid and Interface Science (1994), volume 162, pages 163-170, incorporated herein by reference. This method relies on measuring the increment of liquid volume that enters or leaves a porous material as the differential air pressure is changed between ambient ("lab") air pressure and a slightly elevated air pressure (positive differential pressure) surrounding the specimen in a sample test chamber. The specimen is introduced to the sample chamber dry, and the sample chamber is controlled at a positive differential pressure (relative to the lab) sufficient to prevent fluid uptake into the specimen after the fluid bridge is opened. After opening the fluid bridge, the differential air pressure is decreased in steps to 0, and in this process subpopulations of pores acquire liquid according to their effective pore radius. After reaching a minimal differential pressure at which the mass of fluid within the specimen is at a maximum, differential pressure is increased stepwise again toward the starting pressure, and the liquid is drained from the specimen. It is during this latter draining sequence (from minimal differential pressure, or largest corresponding effective pore radius, to the largest differential pressure, or smallest corresponding effective pore radius), that the fluid retention by the sample (mg) at each differential pressure is determined in this method. After correcting for any fluid movement for each particular pressure step measured on the chamber while empty, the fluid retention by the sample (mg) for each pressure step is determined. The fluid retained may be normalized by dividing the equilibrium quantity of retained liquid (mg) associated with this particular step by the dry weight of the sample (mg).

Sample conditioning and specimen preparation

The Pore Volume Distribution Test Method is conducted on samples that have been conditioned in a room at a temperature of $23^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ and a relative humidity of $50\% \pm 5\%$, all tests are conducted under the same environmental conditions and in such conditioned room. Any damaged product or samples that have defects such as wrinkles, tears, holes, and similar are not tested. Samples conditioned as described herein are considered dry samples for purposes of this invention. A 5.5cm square specimen to be tested is die cut from the conditioned product or sample. The dry specimen weight is measured and recorded.

Apparatus

Apparatus suitable for this method is described in: "Liquid Porosimetry: New Methodology and Applications" by B. Miller and I. Tyomkin published in The Journal of Colloid and Interface Science (1994), volume 162, pages 163-170. Further, any pressure control scheme capable of achieving the required pressures and controlling the sample chamber differential pressure may be used in place of the pressure-control subsystem described in this reference. One example of suitable overall instrumentation and software is the TRI/Autoporosimeter (Textile Research Institute (TRI) / Princeton Inc. of Princeton, N.J., U.S.A.). The TRI/Autoporosimeter is an automated computer-controlled instrument for measuring pore volume distributions in porous materials (e.g., the volumes of different size pores within the range from 1 to 1000 μm effective pore radii). Computer programs such as Automated Instrument Software Releases 2000.1 or 2003.1/2005.1 or 2006.2; or Data Treatment Software Release 2000.1 (available from TRI Princeton Inc.), and spreadsheet programs may be used to capture and analyse the measured data.

Method procedure

The wetting liquid used is a degassed 0.2 weight % solution of octylphenoxy polyethoxy ethanol (Triton X-100 from Sigma-Aldrich) in distilled water. The instrument calculation constants are as follows: ρ (density) = 1 g/cm^3 ; γ (surface tension) = 31 dynes/cm; $\cos\Theta = 1$. A 90-mm diameter mixed-cellulose-ester filter membrane with a characteristic pore size of 1.2 μm (such Millipore Corporation of Bedford, MA, Catalogue #RAWP09025) is affixed to the porous frit (Monel plates with diameter of 90mm, 6.4mm thickness from Mott Corp., Farmington, CT, or equivalent) of the sample chamber. A plexiglass plate weighing about 34 g (supplied with the instrument) is placed on the sample to ensure the sample rests flat on the membrane/frit assembly. No additional weight is placed on the sample.

Someone skilled in the art knows that it is critical to degas the test fluid as well as the frit/membrane/tubing system such that the system is free from air bubbles.

The sequence of pore sizes (differential pressures) for this application is as follows (effective pore radius in μm): 2.5, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 225, 250, 275, 300, 350, 400, 500, 600, 800, 1000. This sequence is then replicated in reverse order. The criterion for moving from one pressure step to the next is that fluid uptake/drainage from the specimen is measured to be less than 10mg/min for 10s.

A separate "blank" measurement is performed by following this method procedure on an empty sample chamber with no specimen or weight present on the membrane/frit assembly. Any fluid movement observed is recorded (mg) at each of the pressure steps. Fluid retention data for a specimen are corrected for any fluid movement associated with the empty sample chamber by subtracting fluid retention values of this "blank" measurement from corresponding values in the measurement of the specimen.

15 Determination of Parameters

Data from the PVD instrument can be presented in a cumulative fashion, so that the cumulative mass absorbed is tabulated alongside the diameter of pore, which allow the following parameters to be calculated:

20 **2.5-160 micron PVD Absorption (mg)** = [mg at 160micron absorbed] – [mg at 2.5micron absorbed] from the advancing curve,

2.5-160 micron PVD Desorption (mg) = [mg at 160micron desorbed] – [mg at 2.5 micron desorbed] from the receding curve, and

25 **2.5-100 micron hysteresis (mg)** = [mg at 100 micron desorbed – mg at 2.5 micron desorbed] – [mg at 100 micron absorbed – mg at 2.5 micron absorbed]

Horizontal Full Sheet (HFS) Test Method:

30 The Horizontal Full Sheet (HFS) test method determines the amount of distilled water absorbed and retained by a fibrous structure of the present invention. This method is performed by first weighing a sample of the fibrous structure to be tested (referred to herein as the "dry weight of the sample"), then thoroughly wetting the sample, draining the wetted sample in a horizontal position and then reweighing (referred to herein as "wet weight of the sample"). The absorptive capacity of the sample is then computed as the amount of water retained in units of grams of water

absorbed by the sample. When evaluating different fibrous structure samples, the same size of fibrous structure is used for all samples tested.

The apparatus for determining the HFS capacity of fibrous structures comprises the following:

5 An electronic balance with a sensitivity of at least ± 0.01 grams and a minimum capacity of 1200 grams. The balance should have a special balance pan to be able to handle the size of the sample tested (i.e.; a fibrous structure sample of about 27.9 cm by 27.9 cm).

10 A sample support rack (FIGS. 14 and 14A) and sample support rack cover (FIGS. 15 and 15A) is also required. Both the support rack (Figs. 14 and 14A) and support rack cover (Figs. 15 and 15A) are comprised of a lightweight metal frame, strung with 0.305 cm diameter monofilament so as to form a grid as shown in FIG. 14. The size of the support rack (FIGS. 14 and 14A) and support rack cover (FIGS. 15 and 15A) is such that the sample size can be conveniently placed between the two.

15 The HFS test is performed in an environment maintained at $23 \pm 1^\circ \text{C}$ and $50 \pm 2\%$ relative humidity. A water reservoir or tub is filled with distilled water at $23 \pm 1^\circ \text{C}$ to a depth of 3 inches (7.6 cm).

20 Samples are tested in duplicate. The dry weight of each sample is reported to the nearest 0.01 grams. The empty sample support rack (FIGS. 14 and 14A) is placed on the balance with the special balance pan described above. The balance is then zeroed (tared). One sample is carefully placed on the sample support rack (FIGS. 14 and 14A), “face up” or with the outside of the sample facing up, away from the sample support rack (FIGS. 14 and 14A). The support rack cover (FIGS. 15 and 15A) is placed on top of the support rack (FIGS. 14 and 14A). The sample (now sandwiched between the rack and cover) is submerged in the water reservoir. After the sample is submerged for 30 ± 3 seconds, the sample support rack (FIGS. 14 and 14A) and support rack cover (FIGS. 15 and 15A) are gently raised out of the reservoir.

25 The sample, support rack (FIGS. 14 and 14A) and support rack cover (FIGS. 15 and 15A) are allowed to drain horizontally for 120 ± 5 seconds, taking care not to excessively shake or vibrate the sample. While the sample is draining, the support rack cover (FIGS. 15 and 15A) is carefully removed and all excess water is wiped from the support rack (FIGS. 15 and 15A). The wet sample and the support rack (FIGS. 14 and 14A) are weighed on the previously tared balance. The weight is recorded to the nearest 0.01g. This is the wet weight of the sample after horizontal drainage.

The HFS gram per gram fibrous structure sample absorptive capacity is defined as:
absorbent capacity = (wet weight of the sample after horizontal drainage - dry weight of the sample)
/ (dry weight of the sample) and has a unit of gram/gram.

The HFS gram per sheet fibrous structure sample absorptive capacity is defined as (wet weight of
5 the sample after horizontal drainage minus dry weight of the sample) and has a unit of gram/sheet.

Vertical Full Sheet (VFS) Test Method:

The Vertical Full Sheet (VFS) test method is similar to the HFS method described
previously, and determines the amount of distilled water absorbed and retained by a fibrous
10 structure when held at an angle of 75°.

After setting up the apparatus, preparing the sample, taking the initial weights, and
submerging the sample, according to the HFS method, the support rack (FIGS. 14 and 14A) and
sample are removed from the reservoir and inclined at an angle of 75° and allowed to drain for
60±5 seconds. Care should be taken so that the sample does not slide or move relative to the support
15 rack (FIGS. 14 and 14A). If there is difficulty keeping the sample from sliding down the support
rack (FIGS. 14 and 14A) sample can be held with the fingers.

At the end of this time frame (60±5 seconds), carefully bring the sample and support rack
(FIGS. 14 and 14A) to the horizontal position and wipe the bottom edge of the sample support rack
(FIGS. 14 and 14A) that water dripped onto during vertical drainage. Return the sample and
20 support rack (FIGS. 14 and 14A) to the balance and take the weight to the nearest 0.01 g. This
value represents the wet weight of the sample after vertical drainage.

The VFS gram per gram fibrous structure sample absorptive capacity is defined as the wet
weight of the sample after vertical drainage minus the dry weight of the sample divided by the dry
weight of the sample, and has a unit of gram/gram (g/g).

25 The VFS gram per sheet fibrous structure sample absorptive capacity is defined as the wet
weight of the sample after vertical drainage minus the dry weight of the sample, and has a unit of
gram/sheet.

The calculated VFS is the average of the absorptive capacities of the two samples of the
fibrous structure.

30

Dry Bulk Ratio Method:

“Dry Bulk Ratio” may be calculated as follows: (Dry Compression x Flexural Rigidity
(avg))/TDT.

Wet Bulk Ratio Method:

“Wet Bulk Ratio” may be calculated as follows: (Wet Compression x Geometric Mean Wet Modulus)/Total Wet Tensile.

5

Fiber Length, Width, Coarseness, and Fiber Count Test Method:

Fiber Length values are generated by running the test procedure as defined in U.S. Patent Application No. 2004-0163782 and informs the following procedure:

The length, width, and coarseness of the-fibers (which are averages of the plurality of fibers being analyzed in a sample), as well as the fiber count (number and/or length average), may be determined using a Valmet FS5 Fiber Image Analyzer commercially available from Valmet, Kajaani Finland (as the Kajaani Fiber Lab is less available) following the procedures outlined in the manual. If in-going or raw pulp is not accessible, samples may be taken from commercially available product (e.g., a roll of sanitary tissue product) to determine length, width, coarseness and fiber count (number and/or length average) using the FQA by obtaining samples as outlined in the “Sample Preparation” section of the Coverage and Fiber Count Test Method in the Test Methods Section. As used herein, fiber length is defined as the “length weighted average fiber length”. The instructions supplied with the unit detail the formula used to arrive at this average. The length can be reported in units of millimeters (mm) or in inches (in). As used herein, fiber width is defined as the “width weighted average fiber width” and can be reported in units of micrometers (μm) or in millimeters (mm). The instructions supplied with the unit detail the formula used to arrive at this average. The width can be reported in units of millimeters (mm) or in inches (in). The instructions supplied with the unit detail the formula used to arrive at this average. Fiber count (number and/or length average) can be reported in units of million fibers/g. As used herein, fiber length/width ratio is defined as the “length weighted average fiber length (mm) / width weighted average fiber width (mm).”

Fiber count (length average, million/g) is calculated from length weighted fiber average and coarseness via the following equation (where L(l) has the units of mm/fiber and coarseness has the units of mg/m): Fiber count = $1/(L(l) \times \text{coarseness})$. And, fiber count (number average, million/g) is calculated from length weighted fiber average and coarseness via the following equation (where L(n) has the units of mm/fiber and coarseness has the units of mg/m): Fiber count = $1/(L(n) \times \text{coarseness})$. (L(l)) means length weighted averaged and (L(n)) means number weighted averaged.

It should be understood that the values from different fiber image analyzers can differ significantly, even as much as 59% – see “Fiber Quality Analysis: OpTest Fiber Quality Analyzer versus L&W Fiber Tester,” Bin Li, Rohan Bandekar, Quanqing Zha, Ahmed Alsaggaf, and Yonghao Ni, *Industrial & Engineering Chemistry Research* 2011 50 (22), 12572-12578, DOI: 10.1021/ie201631q, which compares values from the FQA fiber analyzer to the FT fiber analyzer, stating: “These new instruments, such as PQM (pulp quality monitor), Galai CIS-100, Fiberlab, MorFi, FiberMaster, FQA (fiber quality analyzer), and L&W Fiber Tester (FT), provide fast measurements with the capability of both laboratory and online analysis. However, the measurement differences among these instruments are expected due to the different designs of hardware and software.”

Percent Roll Compressibility Method:

Percent Roll Compressibility (Percent Compressibility) is determined using the Roll Diameter Tester 1000 as shown in FIG. 7. It is comprised of a support stand made of two aluminum plates, a base plate 1001 and a vertical plate 1002 mounted perpendicular to the base, a sample shaft 1003 to mount the test roll, and a bar 1004 used to suspend a precision diameter tape 1005 that wraps around the circumference of the test roll. Two different weights 1006 and 1007 are suspended from the diameter tape to apply a confining force during the uncompressed and compressed measurement. All testing is performed in a conditioned room maintained at about 23 °C ± 2 C° and about 50% ± 2% relative humidity.

The diameter of the test roll is measured directly using a Pi[®] tape or equivalent precision diameter tape (e.g., an Executive Diameter tape available from Apex Tool Group, LLC, Apex, NC, Model No. W606PD) which converts the circumferential distance into a diameter measurement, so the roll diameter is directly read from the scale. The diameter tape is graduated to 0.01 inch increments with accuracy certified to 0.001 inch and traceable to NIST. The tape is 0.25 in wide and is made of flexible metal that conforms to the curvature of the test roll but is not elongated under the 1100 g loading used for this test. If necessary, the diameter tape is shortened from its original length to a length that allows both of the attached weights to hang freely during the test, yet is still long enough to wrap completely around the test roll being measured. The cut end of the tape is modified to allow for hanging of a weight (e.g., a loop). All weights used are calibrated, Class F hooked weights, traceable to NIST.

The aluminum support stand is approximately 600 mm tall and stable enough to support the test roll horizontally throughout the test. The sample shaft 1003 is a smooth aluminum cylinder

that is mounted perpendicularly to the vertical plate 1002 approximately 485 mm from the base. The shaft has a diameter that is at least 90% of the inner diameter of the roll and longer than the width of the roll. A small steel bar 1004 approximately 6.3 mm diameter is mounted perpendicular to the vertical plate 1002 approximately 570 mm from the base and vertically aligned with the sample shaft. The diameter tape is suspended from a point along the length of the bar corresponding to the midpoint of a mounted test roll. The height of the tape is adjusted such that the zero mark is vertically aligned with the horizontal midline of the sample shaft when a test roll is not present.

Condition the samples at about $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and about $50\% \pm 2\%$ relative humidity for 2 hours prior to testing. Rolls with cores that are crushed, bent, or damaged should not be tested.

- 10 Place the test roll on the sample shaft 1003 such that the direction the paper was rolled onto its core is the same direction the diameter tape will be wrapped around the test roll. Align the midpoint of the roll's width with the suspended diameter tape. Loosely loop the diameter tape 1004 around the circumference of the roll, placing the tape edges directly adjacent to each other with the surface of the tape lying flat against the test sample. Carefully, without applying any additional force, hang the 100 g weight 1006 from the free end of the tape, letting the weighted end hang freely without swinging. Wait 3 seconds. At the intersection of the diameter tape 1008, read the diameter aligned with the zero mark of the diameter tape and record as the Original Roll Diameter to the nearest 0.01 inches. With the diameter tape still in place, and without any undue delay, carefully hang the 1000 g weight 1007 from the bottom of the 100 g weight, for a total weight of 1100 g. Wait 3 seconds. Again read the roll diameter from the tape and record as the Compressed Roll Diameter to the nearest 0.01 inch. Calculate percent compressibility to the according to the following equation and record to the nearest 0.1%:

$$\% \text{ Compressibility} = \frac{(\text{Original Roll Diameter}) - (\text{Compressed Roll Diameter})}{\text{Original Roll Diameter}} \times 100$$

Roll Firmness Method:

Roll Firmness is measured on a constant rate of extension tensile tester with computer interface (a suitable instrument is the MTS Alliance using Testworks 4.0 Software, as available from MTS Systems Corp., Eden Prairie, MN) using a load cell for which the forces measured are within 10% to 90% of the limit of the cell. The roll product is held horizontally, a cylindrical probe is pressed into the test roll, and the compressive force is measured versus the depth of penetration.

All testing is performed in a conditioned room maintained at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and $50\% \pm 2\%$ relative humidity.

Referring to FIG. 8, the upper movable fixture 2000 consist of a cylindrical probe 2001 made of machined aluminum with a 19.00 ± 0.05 mm diameter and a length of 38 mm. The end of the cylindrical probe 2002 is hemispheric (radius of 9.50 ± 0.05 mm) with the opposing end 2003 machined to fit the crosshead of the tensile tester. The fixture includes a locking collar 2004 to stabilize the probe and maintain alignment orthogonal to the lower fixture. The lower stationary fixture 2100 is an aluminum fork with vertical prongs 2101 that supports a smooth aluminum sample shaft 2101 in a horizontal position perpendicular to the probe. The lower fixture has a vertical post 2102 machined to fit its base of the tensile tester and also uses a locking collar 2103 to stabilize the fixture orthogonal to the upper fixture.

The sample shaft 2101 has a diameter that is 85% to 95% of the inner diameter of the roll and longer than the width of the roll. The ends of sample shaft are secured on the vertical prongs with a screw cap 2104 to prevent rotation of the shaft during testing. The height of the vertical prongs 2101 should be sufficient to assure that the test roll does not contact the horizontal base of the fork during testing. The horizontal distance between the prongs must exceed the length of the test roll.

Program the tensile tester to perform a compression test, collecting force and crosshead extension data at an acquisition rate of 100 Hz. Lower the crosshead at a rate of 10 mm/min until 5.00 g is detected at the load cell. Set the current crosshead position as the corrected gage length and zero the crosshead position. Begin data collection and lower the crosshead at a rate of 50 mm/min until the force reaches 10 N. Return the crosshead to the original gage length.

Remove all of the test rolls from their packaging and allow them to condition at about $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and about $50\% \pm 2\%$ relative humidity for 2 hours prior to testing. Rolls with cores that are crushed, bent, or damaged should not be tested. Insert sample shaft through the test roll's core and then mount the roll and shaft onto the lower stationary fixture. Secure the sample shaft to the vertical prongs then align the midpoint of the roll's width with the probe. Orient the test roll's tail seal so that it faces upward toward the probe. Rotate the roll 90 degrees toward the operator to align it for the initial compression.

Position the tip of the probe approximately 2 cm above the surface of the sample roll. Zero the crosshead position and load cell and start the tensile program. After the crosshead has returned to its starting position, rotate the roll toward the operator 120 degrees and in like fashion acquire a second measurement on the same sample roll. Up to 4 measurements can be taken per roll.

From the resulting Force (N) verses Distance (mm) curves, read the penetration at 7.00 N as the Roll Firmness and record to the nearest 0.1 mm.

Slip Stick Coefficient of Friction and Kinetic Coefficient of Friction Method:

- 5 The Kinetic Coefficient of Friction values (actual measurements) and Slip Stick Coefficient of Friction (based on standard deviation from the mean Kinetic Coefficient of Friction) are generated by running the test procedure as defined in U.S. Patent No. 9,896,806.

Lint Value Test Method:

- 10 The amount of lint generated from a finished fibrous structure is determined with a Sutherland Rub Tester (available from Danilee Co., Medina, Ohio) and a color spectrophotometer (a suitable instrument is the HunterLab LabScan XE, as available from Hunter Associates Laboratory Inc., Reston, VA, or equivalent). such as the Hunter LabScan XE. The rub tester is a motor-driven instrument for moving a weighted felt test strip over a finished fibrous structure specimen (referred to throughout this method as the “web”) along an arc path. The Hunter Color L value is measured on the felt test strip before and after the rub test. The difference between these two Hunter Color L values is then used to calculate a lint value. This lint method is designed to be used with white or substantially white fibrous structures and/or sanitary toilet tissue products. Therefore, if testing of a non-white tissue, such as blue-colored or peach-colored tissue is desired, 15 the same formulation should be used to make a sample without the colored dye, pigment, etc., using bleached kraft pulps.

i. Sample preparation

- 25 Prior to the lint rub testing, the samples to be tested should be conditioned according to Tappi Method T402OM-88. Here, samples are preconditioned for 24 hours at a relative humidity level of 10 to 35% and within a temperature range of 22°C to 40°C. After this preconditioning step, samples should be conditioned for 24 hours at a relative humidity of 48 to 52% and within a temperature range of 22°C to 24°C. This rub testing should also take place within the confines of the constant temperature and humidity room.

- 30 The web is first prepared by removing and discarding any product which might have been abraded in handling, e.g., on the outside of the roll. For products formed from multiple plies of webs, this test can be used to make a lint measurement on the multi-ply product, or, if the plies can be separated without damaging the specimen, a measurement can be taken on the individual plies

making up the product. If a given sample differs from surface to surface, it is necessary to test both surfaces and average the values in order to arrive at a composite lint value. In some cases, products are made from multiple-ply of webs such that the facing-out surfaces are identical, in which case it is only necessary to test one surface. If both surfaces are to be tested, it is necessary to obtain six specimens for testing (Single surface testing only requires three specimens). Each specimen should measure approximately 9.5 by 4.5 in. (241.3mm by 114mm) with the 9.5 in. (241.3 mm) dimension running in the machine direction (MD). Specimens can be obtained directly from a finished product roll, if the appropriate width, or cut to size using a paper cutter. Each specimen should be folded in half such that the crease is running along the cross direction (CD) of the web sample. For two-surface testing, make up 3 samples with a first surface "out" and 3 with the second-side surface "out". Keep track of which samples are first surface "out" and which are second surface out.

Obtain a 30 in. by 40 in. piece of Crescent #300 cardboard. Using a paper cutter, cut out six pieces of cardboard to dimensions of 2.5 in. by 6 in. Puncture two holes into each of the six cards by forcing the cardboard onto the hold down pins of the Sutherland Rub tester.

Center and carefully place each of the 2.5 in. by 6 in. cardboard pieces on top of the six previously folded samples. Make sure the 6 in. dimension of the cardboard is running parallel to the machine direction (MD) of each of the tissue samples. Center and carefully place each of the cardboard pieces on top of the three previously folded samples. Once again, make sure the 6 in. dimension of the cardboard is running parallel to the machine direction (MD) of each of the web samples.

Fold one edge of the exposed portion of the web specimen onto the back of the cardboard. Secure this edge to the cardboard with adhesive tape obtained from 3M Inc. (3/4 in. wide Scotch Brand, St. Paul, Minn.). Carefully grasp the other over-hanging tissue edge and snugly fold it over onto the back of the cardboard. While maintaining a snug fit of the web specimen onto the board, tape this second edge to the back of the cardboard. Repeat this procedure for each sample.

Turn over each sample and tape the cross-direction edge of the web specimen to the cardboard. One half of the adhesive tape should contact the web specimen while the other half is adhering to the cardboard. Repeat this procedure for each of the samples. If the tissue sample breaks, tears, or becomes frayed at any time during the course of this sample preparation procedure, discard and make up a new sample with a new tissue sample strip.

There will now be 3 first-side surface "out" samples on cardboard and (optionally) 3 second-side surface "out" samples on cardboard.

ii. Felt preparation

Obtain a 30 in. by 40 in. piece of Crescent #300 cardboard. Using a paper cutter, cut out six pieces of cardboard to dimensions of 2.25 in. by 7.25 in. Draw two lines parallel to the short dimension and down 1.125 in. from the top and bottom most edges on the white side of the cardboard. Carefully score the length of the line with a razor blade using a straight edge as a guide. Score it to a depth about halfway through the thickness of the sheet. This scoring allows the cardboard/felt combination to fit tightly around and rest flat against the weight of the Sutherland Rub tester. Draw an arrow running parallel to the long dimension of the cardboard on this scored side of the cardboard.

Cut six pieces of black felt (F-55, or equivalent) to the dimensions of 2.25 in. by 8.5 in. Place a felt piece on top of the unscored, green side of the cardboard such that the long edges of both the felt and cardboard are parallel and in alignment. Make sure the fluffy side of the felt is facing up. Also allow about 0.5" to overhang the top and bottom most edges of the cardboard. Snugly fold over both overhanging felt edges onto the backside of the cardboard and attach with Scotch brand tape. Prepare a total of six of these felt/cardboard combinations. For best reproducibility, all samples should be run with the same lot of felt.

iii. Care of 4-pound weight

The four-pound weight has four square inches of effective contact area providing a contact pressure of one pound per square inch. Since the contact pressure can be changed by alteration of the rubber pads mounted on the face of the weight, it is important to use only the rubber pads supplied by the instrument manufacturer and mounted according to their instructions. These pads must be replaced if they become hard, abraded, or chipped off. When not in use, the weight must be positioned such that the pads are not supporting the full weight of the weight. It is best to store the weight on its side.

iv. Rub tester instrument calibration

Set up and calibrate the Sutherland Rub Tester according to the manufacturer's instructions. For this method, the tester is preset to run for five strokes (one stroke is a full forward and reverse cycle of the movable arm) and operates at 42 cycles per minute.

v. Color spectrophotometer calibration

Setup and standardize the color instrument using a 2 in. measurement area port size utilizing the manufacturer supplied black tile, then white tile. Calibrate the instrument according to manufacturer's specifications using their supplied standard tiles and configure it to measure Hunter

5 L, a, b values.

vi. Measurement of samples

The first step in the measurement of lint is to measure the Hunter color values of the black felt/cardboard samples prior to being rubbed on the web sample. Center a felt covered cardboard,
10 with the arrow pointing to the back of the color meter, over the measurement port backing it with a standard white plate. Since the felt width is only slightly larger than the viewing area diameter, make sure the felt completely covers the measurement area. After confirming complete coverage, take a reading and record the Hunter L value.

Measure the Hunter Color L values for all the felt covered cardboards using this technique.
15 If the Hunter Color L values are all within 0.3 units of one another, take the average to obtain the initial L reading. If the Hunter Color L values are not within the 0.3 units, discard those felt/cardboard combinations outside the limit. Prepare new samples and repeat the Hunter Color L measurement until all samples are within 0.3 units of one another.

For the rubbing of the web sample/cardboard combinations, secure a prepared web sample
20 card on the base plate of the rub tester by slipping the holes in the board over the hold-down pins. Clip a prepared felt covered card (with established initial "L" reading) onto the four-pound weight by pressing the card ends evenly under the clips on the sides of the weight. Make certain the card is centered score bend to score bend on the weight, positioned flat against the rubber pads, with the felt side facing away from the rubber pads. Hook the weight onto the tester arm and gently lower
25 onto the prepared web sample card. It is important to check that the felt is resting flat on the web sample and that the weight does not bind on the arm.

Next, activate the tester allowing the weighted felt test strip to complete five full rubbing strokes against the web sample surface. At the end of the five strokes the tester will automatically stop. Remove the weight with the felt covered cardboard. Inspect the web sample. If torn, discard
30 the felt and web sample and start over. If the web sample is intact, remove the felt covered cardboard from the weight. Measure the Hunter Color L value on the felt covered cardboard in the same location as described above for the blank felts. Record the Hunter Color L readings for the felt after rubbing. Rub, measure, and record the Hunter Color L values for all remaining samples.

After all web specimens have been measured, remove and discard all felt. Felt strips are not used again. Cardboards are used until they are bent, torn, limp, or no longer have a smooth surface.

vii. Calculations

5 For samples measured on both surfaces, subtract the average initial L reading found for the unused felts from each of the three first-side surface L readings and each of the three second-side surface L readings. Calculate the average delta for the three first-side surface values. Calculate the average delta for the three second-side surface values. Finally, calculate the average of the lint value on the first-side surface and the second-side surface, and record as the lint value to the nearest
10 whole unit.

For samples measured on only one surface, subtract the average initial L reading found for the unused felts from each of the three L readings. Calculate the average delta L for the three surface values and record as the lint value to the nearest whole unit.

15 Formation Index Test Method:

The formation index is a ratio of the contrast and size distribution components of the nonwoven substrate. The higher the formation index, the better the formation uniformity. Conversely, the lower the formation index, the worse the formation uniformity. The “formation index” is measured using a commercially available PAPRICAN Micro-Scanner Code LAD94,
20 manufactured by OpTest Equipment, Incorporated, utilizing the software developed by PAPRICAN & OpTest, Version 9.0, both commercially available from OpTest Equipment Inc., Ontario, Canada. The PAPRICAN Micro-Scanner Code LAD94 uses a video camera system for image input and a light box for illuminating the sample. The camera is a CCD camera with 65 µm/pixel resolution.

25 The video camera system views a nonwoven sample placed on the center of a light box having a diffuser plate. To illuminate the sample for imaging, the light box contains a diffused quartz halogen lamp of 82V/250 W that is used to provide a field of illumination. A uniform field of illumination of adjustable intensity is provided. Specifically, samples for the formation index testing are cut from a cross direction width strip of the nonwoven substrate. The samples are cut
30 into 101.6 mm (4 inches) by 101.6 mm (4 inches) squares, with one side aligned with the machine direction of the test material. The side aligned with the machine direction of the test material is placed onto the testing area and held in place by the specimen plate with the machine direction pointed towards the instrument support arm that holds the camera. Each specimen is placed on the

light box such that the side of the web to be measured for uniformity is facing up, away from the diffuser plate. To determine the formation index, the light level must be adjusted to indicate MEAN LCU GRAY LEVEL of 128 ± 1 .

5 The specimen is set on the light box between the specimen plate so that the center of the specimen is aligned with the center of the illumination field. All other natural or artificial room light is extinguished. The camera is adjusted so that its optical axis is perpendicular to the plane of the specimen and so that its video field is centered on the center of the specimen. The specimen is then scanned and calculated with the OpTest Software.

10 Fifteen specimens of the nonwoven substrate were tested for each sample and the values were averaged to determine the formation index.

Density and Bulk (Dry) Test Method:

15 The density of a fibrous structure and/or sanitary tissue product is calculated as the quotient of the Basis Weight of a fibrous structure or sanitary tissue product expressed in lbs/3000 ft² divided by the Caliper (at 95 g/in²) of the fibrous structure or sanitary tissue product expressed in mils. The final Density value is calculated in lbs/ft³ and/or g/cm³, by using the appropriate converting factors. The bulk of a fibrous structure and/or sanitary tissue product is the reciprocal of the density method (i.e., Bulk = 1 / Density).

20 Dry Thick Compression and Recovery Test Method – 1500g (“Dry Compression 1500” or “Compressive Slope (Dry-1500)”):

25 Dry Thick Compression and Dry Thick Compressive Recovery are measured using a constant rate of extension tensile tester (a suitable instrument is the EJA Vantage, Thwing-Albert, West Berlin NJ, or equivalent) fitted with compression fixtures, a circular compression foot having an area of 1.0 in² and a circular anvil having an area of at least 4.9 in². The thickness (caliper in mils) is measured at varying pressure values ranging from 10-1500 g/in² in both the compression and relaxation directions.

30 Four (4) samples are prepared by the cutting of a usable unit obtained from the outermost sheets of a finished product roll after removing at least the leading five sheets by unwinding and tearing off via the closest line of weakness, such that each cut sample is 2.5×2.5 inches, avoiding creases, folds, and obvious defects.

The compression foot and anvil surfaces are aligned parallel to each other, and the crosshead zeroed at the point where they are in contact with each other. The tensile tester is

programmed to perform a compression cycle, immediately followed by an extension (recovery) cycle. Force and extension data are collected at a rate of 50 Hz, with a crosshead speed of 0.10 in/min. Force data is converted to pressure (g/in², or gsi). The compression cycle continues until a pressure of 1500 gsi is reached, at which point the crosshead stops and immediately begins the extension (recovery) cycle with the data collection and crosshead speed remaining the same.

The sample is placed flat on the anvil fixture, ensuring the sample is centered beneath the foot so that when contact is made the edges of the sample will be avoided. Start the tensile tester and data collection. Testing is repeated in like fashion for all four samples.

The thickness (mils) vs. pressure (g/in², or gsi) data is used to calculate the sample's compressibility, near-zero load caliper, and compressive modulus. A least-squares linear regressions is performed on the thickness vs. the logarithm (base10) of the applied pressure data using nine discrete data points at pressures of 10, 25, 50, 75, 100, 125, 150, 200, 300 gsi and their respective thickness readings. Compressibility (m) equals the slope of the linear regression line, with units of mils/log (gsi). The higher the magnitude of the negative value the more "compressible" the sample is. Near-zero load caliper (b) equals the y-intercept of the linear regression line, with units of mils. This is the extrapolated thickness at log (1 gsi pressure). Compressive Modulus is calculated as the y-intercept divided by the negative slope (-b/m) with units of log (gsi).

Dry Thick Compression is defined as:

$$\begin{aligned} \text{Dry Thick Compression (mils} \cdot \text{mils / log (gsi))} \\ = -1 \times \text{Near Zero Load Caliper (b)} \times \text{Compressibility (m)} \end{aligned}$$

Compression Slope is defined as -1 x Compressibility (m).

Multiplication by -1 turns formula into a positive. Larger results represent thick products that compress when a pressure is applied. Calculate the arithmetic mean of the four replicate values and report Dry Thick Compression to the nearest integer value mils* mils / log (gsi).

Dry Thick Compressive Recovery is defined as:

$$\begin{aligned}
 & \text{Dry Thick Compressive Recovery (mils} \cdot \text{mils} / \log (\text{gsi}) \\
 &= -1 \times \text{Near Zero Load Caliper (b)} \times \text{Compressibility (m)} \\
 &\times \frac{\text{Recovered Thickness at 10 gsi}}{\text{Compressed Thickness at 10 gsi}}
 \end{aligned}$$

- 5 Multiplication by -1 turns formula into a positive. Larger results represent thick products that compress when a pressure is applied and maintain fraction recovery at 10 g/in². Compressed thickness at 10 g/in² is the thickness of the material at 10 g/in² pressure during the compressive portion of the test. Recovered thickness at 10 g/in² is the thickness of the material at 10 g/in² pressure during the recovery portion of the test. Calculate the arithmetic mean of the four replicate values and report Dry Thick Compressive Recovery to the nearest integer value mils* mils / log (gsi).

Dry Thick Compression and Recovery Test Method – 200g (“Dry Compression 200” or “Compressive Slope (Dry-200)”):

- 15 Dry Thick Compression and Dry Thick Compressive Recovery are measured using a constant rate of extension compression tester (a suitable instrument is the EJA Vantage, Thwing-Albert, West Berlin NJ, or equivalent) fitted with compression fixtures, a circular compression foot having an area of 1.0 in² and a circular anvil having an area of at least 4.9 in² (calibrated and programmed for fixture deflection compensation). The thickness (caliper in mils) is measured at varying pressure values ranging from 10-200 g/in² in both the compression and relaxation directions.

- 25 Four (4) samples are prepared by the cutting of a usable unit obtained from the outermost sheets of a finished product roll after removing at least the leading five sheets by unwinding and tearing off via the closest line of weakness, such that each cut sample is 2.5×2.5 inches, avoiding creases, folds, and obvious defects.

- 30 The compression foot and anvil surfaces are aligned parallel to each other, and the crosshead zeroed at the point where they are in contact with each other. The tensile tester is programmed to perform a compression cycle, immediately followed by an extension (recovery) cycle. Force and extension data are collected at a rate of 50 Hz, with a crosshead speed of 0.10 in/min. Force data is converted to pressure (g/in², or gsi). The compression cycle continues until a pressure of 200 gsi is reached, at which point the crosshead stops and immediately begins the extension (recovery) cycle with the data collection and crosshead speed remaining the same.

The sample is placed flat on the anvil fixture, ensuring the sample is centered beneath the foot so that when contact is made the edges of the sample will be avoided. Start the compression tester and data collection. Testing is repeated in like fashion for all four samples.

The thickness (mils) vs. pressure (g/in², or gsi) data is used to calculate the sample's compressibility, near-zero load caliper, and compressive modulus. A least-squares linear regressions is performed on the thickness vs. the logarithm (base10) of the applied pressure data using nine discrete data points at pressures of 10, 20, 30, 40, 50, 60, 70, 80, 90gsi and their respective thickness readings (more specifically, the very next data point (pressure and thickness pair) after crossing the respective pressure point). Compressibility-200 (m) equals the slope of the linear regression line, with units of mils/log (gsi). The higher the magnitude of the negative value the more "compressible" the sample is. Near-zero load caliper (b) equals the y-intercept of the linear regression line, with units of mils. This is the extrapolated thickness at log (1 gsi pressure). Compressive Modulus-200 is calculated as the y-intercept divided by the negative slope (-b/m) with units of log (gsi).

Dry Thick Compression is defined as:

$$\begin{aligned} \text{Dry Thick Compression (mils} \cdot \text{mils / log (gsi))} \\ = -1 \times \text{Near Zero Load Caliper (b)} \times \text{Compressibility (m)} \end{aligned}$$

Compression Slope is defined as -1 x Compressibility (m).

Multiplication by -1 turns formula into a positive. Larger results represent thick products that compress when a pressure is applied. Calculate the arithmetic mean of the four replicate values and report Dry Thick Compression to the nearest integer value mils* mils / log (gsi).

Dry Thick Compressive Recovery is defined as:

$$\begin{aligned} \text{Dry Thick Compressive Recovery (mils} \cdot \text{mils / log (gsi))} \\ = -1 \times \text{Near Zero Load Caliper (b)} \times \text{Compressibility (m)} \\ \times \frac{\text{Recovered Thickness at 10 gsi}}{\text{Compressed Thickness at 10 gsi}} \end{aligned}$$

Multiplication by -1 turns formula into a positive. Larger results represent thick products that compress when a pressure is applied and maintain fraction recovery at 10 g/in². Compressed

thickness at 10 g/in² is the thickness of the material at 10 g/in² pressure during the compressive portion of the test. Recovered thickness at 10 g/in² is the thickness of the material at 10 g/in² pressure during the recovery portion of the test. Calculate the arithmetic mean of the four replicate values and report Dry Thick Compressive Recovery to the nearest integer value mils* mils / log (gsi).

Wet Thick Compression and Recovery Test Method (Wet Compression):

Wet Thick Compression and Wet Thick Compressive Recovery are measured using a constant rate of extension tensile tester (a suitable instrument is the EJA Vantage, Thwing-Albert, West Berlin NJ, or equivalent) fitted with compression fixtures, a circular compression foot having an area of 1.0 in² and a circular anvil having an area of at least 4.9 in². The thickness (caliper in mils) is measured at varying pressure values ranging from 10-1500 g/in² in both the compression and relaxation directions.

Four (4) samples are prepared by the cutting of a usable unit obtained from the outermost sheets of a finished product roll after removing at least the leading five sheets by unwinding and tearing off via the closest line of weakness, such that each cut sample is 2.5×2.5 inches, avoiding creases, folds, and obvious defects.

The compression foot and anvil surfaces are aligned parallel to each other, and the crosshead zeroed at the point where they are in contact with each other. The tensile tester is programmed to perform a compression cycle, immediately followed by an extension (recovery) cycle. Force and extension data are collected at a rate of 50 Hz, with a crosshead speed of 0.10 in/min. Force data is converted to pressure (g/in², or gsi). The compression cycle continues until a pressure of 1500 gsi is reached, at which point the crosshead stops and immediately begins the extension (recovery) cycle with the data collection and crosshead speed remaining the same.

The sample is placed flat on the anvil fixture, ensuring the sample is centered beneath the foot so that when contact is made the edges of the sample will be avoided. Using a pipette, fully saturate the entire sample with distilled or deionized water until there is no observable dry area remaining and water begins to run out of the edges. Start the tensile tester and data collection. Testing is repeated in like fashion for all four samples.

The thickness (mils) vs. pressure (g/in², or gsi) data is used to calculate the sample's compressibility, "near-zero load caliper", and compressive modulus. A least-squares linear regressions is performed on the thickness vs. the logarithm (base10) of the applied pressure data using nine discrete data points at pressures of 10, 25, 50, 75, 100, 125, 150, 200, 300 gsi and their

respective thickness readings. Compressibility (m) equals the slope of the linear regression line, with units of mils/log (gsi). The higher the magnitude of the negative value the more “compressible” the sample is. Near-zero load caliper (b) equals the y-intercept of the linear regression line, with units of mils. This is the extrapolated thickness at log (1 gsi pressure).

- 5 Compressive Modulus is calculated as the y-intercept divided by the negative slope (-b/m) with units of log (gsi).

Wet Thick Compression is defined as:

$$\begin{aligned}
 & \text{Dry Thick Compression (mils} \cdot \text{mils} / \log (\text{gsi}) \\
 10 \quad & = -1 \times \text{Near Zero Load Caliper (b)} \times \text{Compressibility (m)}
 \end{aligned}$$

Multiplication by -1 turns formula into a positive. Larger results represent thick products that compress when a pressure is applied. Calculate the arithmetic mean of the four replicate values and report Wet Thick Compression to the nearest integer value mils* mils / log (gsi).

- 15 Wet Thick Compressive Recovery is defined as:

$$\begin{aligned}
 & \text{Dry Thick Compressive Recovery (mils} \cdot \text{mils} / \log (\text{gsi}) \\
 & = -1 \times \text{Near Zero Load Caliper (b)} \times \text{Compressibility (m)} \\
 & \times \frac{\text{Recovered Thickness at 10 gsi}}{\text{Compressed Thickness at 10 gsi}}
 \end{aligned}$$

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Multiplication by -1 turns formula into a positive. Larger results represent thick products that compress when a pressure is applied and maintain fraction recovery at 10 g/in². Compressed thickness at 10 g/in² is the thickness of the material at 10 g/in² pressure during the compressive portion of the test. Recovered thickness at 10 g/in² is the thickness of the material at 10 g/in² pressure during the recovery portion of the test. Calculate the arithmetic mean of the four replicate values and report Wet Thick Compressive Recovery to the nearest integer value mils* mils / log (gsi).

25

Moist Towel Surface Structure Test Method:

- 30 This test method measures the surface topography of a towel surface, both in a dry and moist state, and calculates the % contact area and the median depth of the lowest 10% of the projected measured area, with the test sample under a specified pressure using a smooth and rigid

transparent plate with an anti-reflective coating (to minimize and/or eliminate invalid image pixels).

Condition the samples or useable units of product, with wrapper or packaging materials removed, in a room conditioned at $50 \pm 2\%$ relative humidity and $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($73^{\circ} \pm 2^{\circ}\text{F}$) for a minimum of two hours prior to testing. Do not test useable units with defects such as wrinkles, tears, holes, effects of tail seal or core adhesive, etc., and when necessary, replace with other useable units free of such defects. Test sample dimensions shall be of the size of the usable unit, removed carefully at the perforations if they are present. If perforations are not present, or for samples larger than 8 inches MD by 11 inches CD, cut the sample to a length of approximately 6 inches in the MD and 11 inches in the CD. In this test only the inside surface of the usable unit(s) is analyzed. The inside surface is identified as the surface oriented toward the interior core when wound on a product roll (i.e., the opposite side of the surface visible on the outside roll as presented to a consumer).

The instrument used in this method is a Gocator 3210 Snapshot System (LMI Technologies, Inc., 9200 Glenlyon Parkway, Burnaby, BC V5J 5J8 Canada), or equivalent. This instrument is an optical 3D surface topography measurement system that measures the surface height of a sample using a projected structured light pattern technique. The result of the measurement is a topography map of surface height (z-directional or z-axis) versus displacement in the x-y plane. This particular system has a field of view of approximately 100 x 154 mm, however the captured images are cropped to 80 x 130 mm (from the center) prior to analysis. The system has an x-y pixel resolution of 86 microns. The clearance distance from the camera to the testing surface (which is smooth and flat, and perpendicular to the camera view) is 23.5 (+/- 0.2) cm – see FIG. 10. Calibration plates can be used to verify that the system is accurate to manufacturer's specifications. The system is set to a Brightness value of 7, and a Dynamic value of 3, in order to most accurately capture the surface topography and minimize non-measured pixels and noise. Other camera settings may be used, with the objective of most accurately measuring the surface topography, while minimizing the number of invalid and non-measurable points.

Test samples are handled only at their corners. The test sample is first weighted on a scale with at least 0.001 gram accuracy, and its dry weight recorded to the nearest 0.01 gram. It is then placed on the testing surface, with its inside face oriented towards the Gocator camera, and centered with respect to the imaging view. A smooth and rigid transparent plate (8 x 10 inches) is gently placed on top of the test sample, centered with respect to its x-y dimensions. Equal size weights are placed on the four corners of the transparent plate such that they are close to the four corners

of the projected imaged area, but do not interfere in any way with the measurement image. The size of each equal sized weight is such that the total weight of transparent plate and the four weights delivers a total pressure of 25 (+/- 1) grams per square inch (gsi) to the test sample under the plate. Within 15 seconds of placing the four weights in their proper position, the Gocator system is then initiated to acquire the topography image of the test sample in its 'dry' state.

Immediately after saving the Gocator image of the 'dry' state image, the weights and plate are removed from the test sample. The test sample is then moved to a smooth, clean countertop surface, with its inside face still up. Using a pipette, 15-30 ml of deionized water is distributed evenly across the entire surface of the test sample until it is visibly apparent that the water has fully wetted the entire test sample, and no unwetted area is observed. The wetting process is to be completed in less than a minute. The wet test sample is then gently picked up by two adjacent corners, so that it hangs freely (dripping may occur), and carefully placed on a sheet of blotter paper (Whatman cellulose blotting paper, grade GB003, cut to dimensions larger than the test sample). The wet test sample must be placed flat on the blotting paper without wrinkles or folds present. A smooth, 304 stainless steel cylindrical rod (density of $\sim 8 \text{ g/cm}^3$), with dimensions of 1.75 inch diameter and 12 inches long, is then rolled over the entire test sample at a speed of 1.5 – 2.0 inches per second, in the direction of the shorter of the two dimensions of the test sample. If creases or folds are created during the rolling process, and are inside the central area of the sample to be measured (i.e., if they cannot slightly adjusted or avoided in the topography measurement), then the test sample is to be discarded for a new test sample, and the measurement process started over. Otherwise, the moist sample is picked up by two adjacent corners and weighed on the scale to the nearest 0.01 gram (i.e., its moist weight). At this point, the moist test paper towel test sample will have a moisture level between 1.25 and 2.00 grams H_2O per gram of initial dry material.

The moist test sample is then placed flat on the Gocator testing surface (handling it carefully, only touching its corners), with its inside surface pointing towards the Gocator camera, and centered with respect to the imaging view (as close to the same position it was for the 'dry' state image). After ensuring that the sample is flat, and no folds or creases are present in the imaging area, the smooth and rigid transparent plate (8 x 10 inches) is gently placed on top of the test sample, centered with respect to its x-y dimensions. The equal size weights are placed on the four corners of the transparent plate (i.e., the same weights that were used in the dry sample testing) such that they are close to the four corners of the projected imaged area, but do not interfere in any way with the measurement image. Within 15 seconds of placing the four weights in their proper

position, the Gocator system is then initiated to acquire the topography image of the test sample in its ‘moist’ state.

At this point, the test sample has both ‘dry’ and ‘moist’ surface topography (3D) images. These are processed using surface texture analysis software such as MountainsMap® (available from Digital Surf, France) or equivalent, as follows: 1) The first step is to crop the image. As stated previously, this particular system has a field of view of approximately 100 x 154 mm, however the image is cropped to 80 x 130 mm (from the center). 2) Remove ‘invalid’ and non-measured points. 3) Apply a 3x3 median filter (to reduce effects of noise). 4) Apply an ‘Align’ filter, which subtracts a least squares plane to level the surface (to create an overall average of heights centered at zero). 5) Apply a Gaussian filter (according to ISO 16610-61) with a nesting index (cut-off wavelength) of 25 mm (to flatten out large scale waviness, while preserving finer structure).

From these processed 3D images of the surface, the following parameters are calculated, using software such as MountainsMap® or equivalent: Dry Depth (um), Dry Contact Area (%), Moist Depth (um), and Moist Contact Area (%).

Height measurements are derived from the Areal Material Ratio (Abbott-Firestone) curve described in the ISO 13565-2:1996 standard extrapolated to surfaces. This curve is the cumulative curve of the surface height distribution histogram versus the range of surface heights measured. A material ratio is the ratio, expressed as a percent, of the area corresponding to points with heights equal to or above an intersecting plane passing through the surface at a given height, or cut depth, to the cross-sectional area of the evaluation region (field of view area). For calculating contact area, the height at a material ratio of 2% is first identified. A cut depth of 100 µm below this height is then identified, and the material ratio at this depth is recorded as the “Dry Contact Area” and “Moist Contact Area”, respectively, to the nearest 0.1%.

In order to calculate “Depth” (Dry and Moist, respectively), the depth at the 95% material ratio relative to the mean plane (centered height data) of the specimen surface is identified. This corresponds to a depth equal to the median of the lowest 10% of the projected area (valleys) of the specimen surface and is recorded as the “Dry Depth” and “Moist Depth”, respectively, to the nearest 1 micron (um). These values will be negative as they represent depths below the mean plane of the surface heights having a value of zero.

Three replicate samples are prepared and measured in this way, to produce an average for each of the four parameters: Dry Depth (um), Dry Contact Area (%), Moist Depth (um), and Moist

Contact Area (%). Additionally, from these parameters, the difference between the dry and moist depths can be calculated to demonstrate the change in depth from the dry to the moist state.

Micro-CT Intensive Property Measurement Method:

5 The micro-CT intensive property measurement method measures the basis weight, thickness and density values within visually discernable zones or regions of a substrate sample. It is based on analysis of a 3D x-ray sample image obtained on a micro-CT instrument (a suitable instrument is the Scanco μ CT 50 available from Scanco Medical AG, Switzerland, or equivalent). The micro-CT instrument is a cone beam microtomograph with a shielded cabinet. A maintenance
10 free x-ray tube is used as the source with an adjustable diameter focal spot. The x-ray beam passes through the sample, where some of the x-rays are attenuated by the sample. The extent of attenuation correlates to the mass of material the x-rays have to pass through. The transmitted x-rays continue on to the digital detector array and generate a 2D projection image of the sample. A 3D image of the sample is generated by collecting several individual projection images of the
15 sample as it is rotated, which are then reconstructed into a single 3D image. The instrument is interfaced with a computer running software to control the image acquisition and save the raw data. The 3D image is then analyzed using image analysis software (a suitable image analysis software is MATLAB available from The Mathworks, Inc., Natick, MA, or equivalent) to measure the basis weight, thickness and density intensive properties of regions within the sample.

20

Sample Preparation

To obtain a sample for measurement, lay a single layer of the dry substrate material out flat and die cut a circular piece with a diameter of 16 mm. If the sample being measured is a 2 (or more) ply finished product, carefully separate an individual ply of the finished product prior to die
25 cutting. The sample weight is recorded. A sample may be cut from any location containing the region or cells to be analyzed. Regions, zones, or cells within different samples taken from the same substrate material can be analyzed and compared to each other. Care should be taken to avoid embossed regions, folds, wrinkles, or tears when selecting a location for sampling.

30

Image Acquisition

Set up and calibrate the micro-CT instrument according to the manufacturer's specifications. Place the sample into the appropriate holder, between two rings of low-density material, which have an inner diameter of 12 mm. This will allow the central portion of the sample

to lay horizontal and be scanned without having any other materials directly adjacent to its upper and lower surfaces. Measurements should be taken in this region. The 3D image field of view is approximately 20 mm on each side in the xy-plane with a resolution of approximately 3400 by 3400 pixels, and with a sufficient number of 6 micron thick slices collected to fully include the z-direction of the sample. The reconstructed 3D image contains isotropic voxels of 6 microns. Images were acquired with the source at 45 kVp and 133 μ A with no additional low energy filter. These current and voltage settings should be optimized to produce the maximum contrast in the projection data with sufficient x-ray penetration through the sample, but once optimized held constant for all substantially similar samples. A total of 1700 projections images are obtained with an integration time of 500 ms and 4 averages. The projection images are reconstructed into the 3D image and saved in 16-bit format to preserve the full detector output signal for analysis.

Image Processing

Load the 3D image into the image analysis software. The largest cross-sectional area of the sample should be nearly parallel with the x-y plane, with the z-axis being perpendicular. Threshold the 3D image at a value which separates, and removes, the background signal due to air, but maintains the signal from the sample fibers within the substrate.

Five 2D intensive property images are generated from the thresholded 3D image. The first is the Basis Weight Image, which is a projection image. Each x-y pixel in this image represents the summation of the intensity values along voxels in the z-direction. This results in a 2D image where each pixel now has a value equal to the cumulative signal through the entire sample.

The weight of the sample divided by the z-direction projected area of the punched sample provides the actual average basis weight of the sample. This correlates with the average signal intensity from the Basis Weight image described above, allowing it to be represented in units of g/m^2 (gsm).

The second intensive property 2D image is the Thickness Image. To generate this image the upper and lower surfaces of the sample are identified, and the distance between these surfaces is calculated giving the sample thickness. The upper surface of the sample is identified by starting at the uppermost z-direction slice and evaluating each slice going through the sample to locate the z-direction voxel for all pixel positions in the xy-plane where sample signal was first detected. The same procedure is followed for identifying the lower surface of the sample, except the z-direction voxels located are all the positions in the xy-plane where sample signal was last detected. Once the upper and lower surfaces have been identified they are smoothed with a 15x15 median filter to remove signal from stray fibers. The 2D Thickness Image is then generated by counting the

number of voxels that exist between the upper and lower surfaces for each of the pixel positions in the xy-plane. This raw thickness value is then converted to actual distance, in microns, by multiplying the voxel count by the 6 μm slice thickness resolution.

The third intensive property 2D image is the Density Image (see for example FIG. 12). To
5 generate this image, divide each xy-plane pixel value in the Basis Weight Image, in units of gsm, by the corresponding pixel in the Thickness Image, in units of microns. The units of the Density Image are grams per cubic centimeter (g/cc).

For each x-y location, the first and last occurrence of a thresholded voxel position in the z-direction is recorded. This provides two sets of points representing the Top Layer and Bottom
10 Layer of the sample. Each set of points are fit to a second-order polynomial to provide smooth top and bottom surfaces. These surfaces define fourth and fifth 2D intensive property images, the top-layer and bottom-layer of the sample. These surfaces are saved as images with the gray values of each pixel representing the z-value of the surface point.

15 Micro-CT Basis Weight, Thickness and Density Intensive Properties

This sub-section of the method may be used to measure zones or regions generally. Begin by identifying the zone or region to be analyzed. Next, identify the boundary of the identified region to be analyzed. The boundary of a region is identified by visual discernment of differences in intensive properties when compared to other regions within the sample. For example, a region
20 boundary can be identified based by visually discerning a thickness difference when compared to another region in the sample. Any of the intensive properties can be used to discern region boundaries on either on the physical sample itself or any of the micro-CT intensive property images. Once the boundary of a zone or region has been identified draw the largest circular region of interest that can be inscribed within the region. From each of the first three intensive property
25 images calculate the average basis weight, thickness, and density within the region of interest. Record these values as the region's micro-CT basis weight to the nearest 0.01 gsm, micro-CT thickness to the nearest 0.1 micron and micro-CT density to the nearest 0.0001 g/cc.

To calculate the percent difference between zones or regions may be calculated according to the "Percent (%) difference" definition above.

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Concavity Ratio and Packing Fraction Measurements

As outlined above, five different types of 2D intensive property images are created. These images include: (1) a basis weight image, (2) a thickness image, (3) a density image, (4) a top-layer image, and (5) a bottom-layer image.

To measure discrete pillow and knuckle Concavity Ratio and Packing Fraction, begin by identifying the boundary of the selected discrete pillow or knuckle cells. The boundary of a cell is identified by visual discernment of differences in intensive properties when compared to other cells within the sample. For example, a cell boundary can be identified based by visually discerning a density difference when compared to another cell in the sample. Any of the intensive properties (basis weight, thickness, density, top-layer, and bottom-layer) can be used to discern cell boundaries on either the physical sample itself or any of the micro-CT 2D intensive property images.

Using the image analysis software, manually draw a line tracing the identified boundary of each individual whole and partial discrete knuckle or discrete pillow cell visible within the sample boundary 100, and generate a new binary image containing only the closed filled in shapes of all the identified discrete cells (see for example FIG. 13). Analyze all the individual discrete cell shapes in the binary image and record the following measurements for each: 1) Area and 2) Convex Hull Area.

The Concavity Ratio is a measure of the presence and extent of concavity within the shapes of the discrete knuckle or pillow cells. Using the recorded measurements calculate the Concavity Ratio for each of the analyzed discrete cells as the ratio of the shape area to its convex hull area. Identify ten substantially similar replicate discrete knuckle or pillow cells and average together their individual Concavity Ratio values and report the average Concavity Ratio as a unitless value to the nearest 0.01. If ten replicate cells cannot be identified in a single sample, then a sufficient number of replicate samples are to be analyzed according to the described procedure. If the sample contains discrete knuckle or pillow cells of differing size or shape, identify ten substantially similar replicates of each of the different shapes and sizes, calculate an average Concavity Ratio for each and report the minimum average Concavity Ratio value.

The Packing Fraction is the fraction of the sample area filled by the discrete knuckle and pillow shapes. The Packing Fraction value for the sample is calculated by summing all the recorded whole and partial identified shape areas, regardless of shape or size, and dividing that total by the sample area within the sample boundary 100. The Packing Fraction is reported as a unitless value to the nearest 0.01.

Continuous Region Density Difference Measurement

This sub-section of the method may be used when a continuous region is present. To measure the Continuous Region Density Difference, first identify a Cell Group of four adjacent

and nearest-neighboring discrete knuckle (e.g., FIG. 11, 20-A through 20-D) or pillow cells and their boundaries as described above, such that when the centroids of each of the four cells are connected a quadrilateral will be formed having four edges 90 and two diagonals 92 (see for example FIG. 11). Avoid analyzing any Cells Groups containing embossing. Within this Cell

5 Group identify the continuous pillow or knuckle region. Select five locations to analyze within the identified continuous region: One will be located on each of the cell centroid connecting lines forming the four edges of the quadrilateral, and one located in the middle where the quadrilateral diagonals intersect. At each of the selected locations draw the largest circular region of interest that can be inscribed within the continuous region, with the center of each of the four edge regions of

10 interest lying on the centroid connecting line (e.g., pillow regions 22-1, 22-3, 22-8, 22-9) and the middle region of interest centered at the location where the diagonals intersect (e.g., 22-2). From the density intensive property image calculate and record the average density within each of the five regions of interest. Calculate and record the percent difference between the highest and lowest recorded density values. Percent difference is calculated by: subtracting the lowest density value

15 from the highest density value and then dividing that value by the average of the lowest and highest density values, and then multiplying the result by 100. Perform this analysis for three substantially similar replicate Cell Groups of four discrete knuckle or pillow locations within the sample and report the average percent difference value to the nearest whole percent.

20 Continuous Region Density Difference Measurement

This sub-section of the method may be used when a continuous region is present. To measure the Continuous Region Density Difference, first identify a Cell Group 40 of four adjacent and nearest-neighboring discrete knuckle (e.g., FIG. 11, 20-A through 20-D) or pillow cells and their boundaries as described above, such that when the centroids of each of the four cells are

25 connected a quadrilateral will be formed having four edges 90 and two diagonals 92 (see for example FIG. 11). Avoid analyzing any Cells Groups containing embossing. Within this Cell Group identify the continuous pillow or knuckle region. Select five locations to analyze within the identified continuous region: One will be located on each of the cell centroid connecting lines forming the four edges of the quadrilateral, and one located in the middle where the quadrilateral

30 diagonals intersect. At each of the selected locations draw the largest circular region of interest that can be inscribed within the continuous region, with the center of each of the four edge regions of interest lying on the centroid connecting line (e.g., pillow regions 22-1, 22-3, 22-8, 22-9) and the middle region of interest centered at the location where the diagonals intersect (e.g., 22-2). From

the density intensive property image calculate and record the average density within each of the five regions of interest. Calculate and record the percent difference between the highest and lowest recorded density values. Percent difference is calculated by: subtracting the lowest density value from the highest density value and then dividing that value by the average of the lowest and highest density values, and then multiplying the result by 100. Perform this analysis for three substantially similar replicate Cell Groups of four discrete knuckle or pillow locations within the sample and report the average percent difference value to the nearest whole percent.

Micro-CT Basis Weight, Thickness and Density Intensive Properties

This sub-section of the method may be used to measure zones or regions generally. Once the boundary of a zone or region has been identified draw the largest circular region of interest that can be inscribed within the region. From each of the first three intensive property images calculate the average basis weight, thickness and density within the region of interest. Record these values as the region's micro-CT basis weight to the nearest 0.01 gsm, micro-CT thickness to the nearest 0.1 micron and micro-CT density to the nearest 0.0001 g/cc. To calculate and record the percent difference between ZONES OR REGIONS: the highest and lowest recorded density values. Percent difference is calculated by: subtracting the lowest density value from the highest density value and then dividing that value by the average of the lowest and highest density values, and then multiplying the result by 100.

Basis Weigh- Method:

Basis weight of a fibrous structure and/or sanitary tissue product (TAPPI conditioned as follows: Temperature is controlled from $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and Relative Humidity is controlled from $50\% \pm 2\%$) is measured on stacks of twelve usable units using a top loading analytical balance with a resolution of ± 0.001 g. The balance is protected from air drafts and other disturbances using a draft shield. A precision cutting die, measuring 3.500 in ± 0.0035 in by 3.500 in ± 0.0035 in is used to prepare all samples.

With a precision cutting die, cut the samples into squares. Combine the cut squares to form a stack twelve samples thick. Measure the mass of the sample stack and record the result to the nearest 0.001 g.

The Basis Weight is calculated in lbs/3000 ft² or g/m² as follows:

$$\text{Basis Weight} = (\text{Mass of stack}) / [(\text{Area of 1 square in stack}) \times (\text{No. of squares in stack})]$$

For example:

$$\text{Basis Weight (lbs/3000 ft}^2\text{)} = \left[\frac{\text{Mass of stack (g)}}{453.6 \text{ (g/lbs)}} \right] \left[\frac{12.25 \text{ (in}^2\text{)}}{144 \text{ (in}^2\text{/ft}^2\text{)}} \times 12 \right] \times 3000$$

or,

5 $\text{Basis Weight (g/m}^2\text{)} = \text{Mass of stack (g)} / [79.032 \text{ (cm}^2\text{)} / 10,000 \text{ (cm}^2\text{/m}^2\text{)} \times 12].$

Report the numerical result to the nearest 0.1 lbs/3000 ft² or 0.1 g/m² or “gsm.” Sample dimensions can be changed or varied using a similar precision cutter as mentioned above, so as at least 100 square inches of sample area in stack.

10 Emtec Test Method:

TS7 and TS750 values are measured using an EMTEC Tissue Softness Analyzer ("Emtec TSA") (Emtec Electronic GmbH, Leipzig, Germany) interfaced with a computer running Emtec TSA software (version 3.19 or equivalent). According to Emtec, the TS7 value correlates with the real material softness, while the TS750 value correlates with the felt smoothness/roughness of the material. The Emtec TSA comprises a rotor with vertical blades which rotate on the test sample at a defined and calibrated rotational speed (set by manufacturer) and contact force of 100 mN. Contact between the vertical blades and the test piece creates vibrations, which create sound that is recorded by a microphone within the instrument. The recorded sound file is then analyzed by the Emtec TSA software. The sample preparation, instrument operation and testing procedures are performed according the instrument manufacture's specifications.

15

20

Sample Preparation

Test samples are prepared by cutting square or circular samples from a finished product. Test samples are cut to a length and width (or diameter if circular) of no less than about 90 mm, and no greater than about (“no greater than about” used interchangeably with “less than about” herein) 120 mm, in any of these dimensions, to ensure the sample can be clamped into the TSA instrument properly. Test samples are selected to avoid perforations, creases or folds within the testing region. Prepare 8 substantially similar replicate samples for testing. Equilibrate all samples at TAPPI standard temperature and relative humidity conditions (23 °C ± 2 °C and 50 % ± 2 %) for at least 1 hour prior to conducting the TSA testing, which is also conducted under TAPPI conditions.

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Testing Procedure

Calibrate the instrument according to the manufacturer's instructions using the 1-point calibration method with Emtec reference standards (“ref.2 samples”). If these reference samples

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are no longer available, use the appropriate reference samples provided by the manufacturer. Calibrate the instrument according to the manufacturer's recommendation and instruction, so that the results will be comparable to those obtained when using the 1-point calibration method with Emtec reference standards ("ref.2 samples").

- 5 Mount the test sample into the instrument and perform the test according to the manufacturer's instructions. When complete, the software displays values for TS7 and TS750. Record each of these values to the nearest 0.01 dB V² rms. The test piece is then removed from the instrument and discarded. This testing is performed individually on the top surface (outer facing surface of a rolled product) of four of the replicate samples, and on the bottom surface (inner
- 10 facing surface of a rolled product) of the other four replicate samples.

- The four test result values for TS7 and TS750 from the top surface are averaged (using a simple numerical average); the same is done for the four test result values for TS7 and TS750 from the bottom surface. Report the individual average values of TS7 and TS750 for both the top and bottom surfaces on a particular test sample to the nearest 0.01 dB V² rms. Additionally, average
- 15 together all eight test value results for TS7 and TS750, and report the overall average values for TS7 and TS750 on a particular test sample to the nearest 0.01 dB V² rms. Unless otherwise specified, the reported values for TS7 and TS750 will be the overall average of the eight test values from the top and bottom surfaces.

- 20 SST Absorbency Rate Method:

This test incorporates the Slope of the Square Root of Time (SST) Test Method. The SST method measures rate over a wide spectrum of time to capture a view of the product pick-up rate over the useful lifetime. In particular, the method measures the absorbency rate via the slope of the mass versus the square root of time from 2-15 seconds.

25

Overview

- The absorption (wicking) of water by a fibrous sample is measured over time. A sample is placed horizontally in the instrument and is supported with minimal contact during testing (without allowing the sample to droop) by an open weave net structure that rests on a balance. The test is
- 30 initiated when a tube connected to a water reservoir is raised and the meniscus makes contact with the center of the sample from beneath, at a small negative pressure. Absorption is controlled by the ability of the sample to pull the water from the instrument for approximately 20 seconds. Rate is determined as the slope of the regression line of the outputted weight vs sqrt(time) from 2 to 15 seconds.

Apparatus

Conditioned Room - Temperature is controlled from $73^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 1^{\circ}\text{C}$). Relative Humidity is controlled from $50\% \pm 2\%$

5 Sample Preparation – Product samples are cut using hydraulic/pneumatic precision cutter into 3.375 inch diameter circles.

Capacity Rate Tester (CRT) - The CRT is an absorbency tester capable of measuring capacity and rate. The CRT consists of a balance (0.001g), on which rests on a woven grid (using nylon monofilament line having a 0.014" diameter) placed over a small reservoir with a delivery
10 tube in the center. This reservoir is filled by the action of solenoid valves, which help to connect the sample supply reservoir to an intermediate reservoir, the water level of which is monitored by an optical sensor. The CRT is run with a -2mm water column, controlled by adjusting the height of water in the supply reservoir.

A diagram of the testing apparatus set up is shown in FIG. 9.

15 Software - LabView based custom software specific to CRT Version 4.2 or later.

Water - Distilled water with conductivity $< 10 \mu\text{S}/\text{cm}$ (target $< 5 \mu\text{S}/\text{cm}$) @ 25°C

Sample Preparation

For this method, a usable unit is described as one finished product unit regardless of the
20 number of plies. Condition all samples with packaging materials removed for a minimum of 2 hours prior to testing. Discard at least the first ten usable units from the roll. Remove two usable units and cut one 3.375-inch circular sample from the center of each usable unit for a total of 2 replicates for each test result. Do not test samples with defects such as wrinkles, tears, holes, etc. Replace with another usable unit which is free of such defects

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Sample Testing

Pre-test set-up

1. The water height in the reservoir tank is set -2.0 mm below the top of the support rack (where the towel sample will be placed).
- 30 2. The supply tube (8mm I.D.) is centered with respect to the support net.
3. Test samples are cut into circles of 3-3/8" diameter and equilibrated at Tappi environment conditions for a minimum of 2 hours.

Test Description

1. After pressing the start button on the software application, the supply tube moves to 0.33 mm below the water height in the reserve tank. This creates a small meniscus of water above the supply tube to ensure test initiation. A valve between the tank and the supply tube closes, and the scale is zeroed.
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2. The software prompts you to “load a sample”. A sample is placed on the support net, centering it over the supply tube, and with the side facing the outside of the roll placed downward.
3. Close the balance windows and press the “OK” button -- the software records the dry weight of the circle.
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4. The software prompts you to “place cover on sample”. The plastic cover is placed on top of the sample, on top of the support net. The plastic cover has a center pin (which is flush with the outside rim) to ensure that the sample is in the proper position to establish hydraulic connection. Four other pins, 1 mm shorter in depth, are positioned 1.25-1.5 inches radially away from the center pin to ensure the sample is flat during the test. The sample cover rim should not contact the sheet. Close the top balance window and click “OK”.
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5. The software re-zeroes the scale and then moves the supply tube towards the sample. When the supply tube reaches its destination, which is 0.33 mm below the support net, the valve opens (i.e., the valve between the reserve tank and the supply tube), and hydraulic connection is established between the supply tube and the sample. Data acquisition occurs at a rate of 5 Hz and is started about 0.4 seconds before water contacts the sample.
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6. The test runs for at least 20 seconds. After this, the supply tube pulls away from the sample to break the hydraulic connection.
7. The wet sample is removed from the support net. Residual water on the support net and cover are dried with a paper towel.
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8. Repeat until all samples are tested.
9. After each test is run, a *.txt file is created (typically stored in the CRT/data/rate directory) with a file name as typed at the start of the test. The file contains all the test set-up parameters, dry sample weight, and cumulative water absorbed (g) vs. time (sec) data collected from the test.
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Calculation of Rate of Uptake

Take the raw data file that includes time and weight data.

First, create a new time column that subtracts 0.4 seconds from the raw time data to adjust the raw time data to correspond to when initiation actually occurs (about 0.4 seconds after data collection begins).

Second, create a column of data that converts the adjusted time data to square root of time data (e.g., using a formula such as SQRT() within Excel).

Third, calculate the slope of the weight data vs the square root of time data (e.g., using the SLOPE() function within Excel, using the weight data as the y-data and the sqrt(time) data as the x-data, etc.). The slope should be calculated for the data points from 2 to 15 seconds, inclusive (or 1.41 to 3.87 in the sqrt(time) data column).

Calculation of Slope of the Square Root of Time (SST)

The start time of water contact with the sample is estimated to be 0.4 seconds after the start of hydraulic connection is established between the supply tube and the sample (CRT Time). This is because data acquisition begins while the tube is still moving towards the sample and incorporates the small delay in scale response. Thus, “time zero” is actually at 0.4 seconds in CRT Time as recorded in the *.txt file.

The slope of the square root of time (SST) from 2-15 seconds is calculated from the slope of a linear regression line from the square root of time between (and including) 2 to 15 seconds (x-axis) versus the cumulative grams of water absorbed. The units are g/sec^{0.5}.

Reporting Results

Report the average slope to the nearest 0.01 g/s^{0.5}.

Plate Stiffness Test Method:

As used herein, the “Plate Stiffness” test is a measure of stiffness of a flat sample as it is deformed downward into a hole beneath the sample. For the test, the sample is modeled as an infinite plate with thickness “t” that resides on a flat surface where it is centered over a hole with radius “R”. A central force “F” applied to the tissue directly over the center of the hole deflects the tissue down into the hole by a distance “w”. For a linear elastic material, the deflection can be predicted by:

$$w = \frac{3F}{4\pi Et^3} (1-\nu)(3+\nu)R^2$$

where “E” is the effective linear elastic modulus, “v” is the Poisson's ratio, “R” is the radius of the hole, and “t” is the thickness of the tissue, taken as the caliper in millimeters measured on a stack of 5 tissues under a load of about 0.29 psi. Taking Poisson's ratio as 0.1 (the solution is not highly sensitive to this parameter, so the inaccuracy due to the assumed value is likely to be minor), the previous equation can be rewritten for “w” to estimate the effective modulus as a function of the flexibility test results:

$$E \approx \frac{3R^2}{4t^3} \frac{F}{w}$$

The test results are carried out using an MTS Alliance RT/1, Insight Renew, or similar model testing machine (MTS Systems Corp., Eden Prairie, Minn.), with a 50 newton load cell, and data acquisition rate of at least 25 force points per second. As a stack of five tissue sheets (created without any bending, pressing, or straining) at least 2.5-inches by 2.5 inches, but no more than 5.0 inches by 5.0 inches, oriented in the same direction, sits centered over a hole of radius 15.75 mm on a support plate, a blunt probe of 3.15 mm radius descends at a speed of 20 mm/min. For typical perforated rolled bath tissue, sample preparation consists of removing five (5) connected usable units, and carefully forming a 5 sheet stack, accordion style, by bending only at the perforation lines. When the probe tip descends to 1 mm below the plane of the support plate, the test is terminated. The maximum slope (using least squares regression) in grams of force/mm over any 0.5 mm span during the test is recorded (this maximum slope generally occurs at the end of the stroke). The load cell monitors the applied force and the position of the probe tip relative to the plane of the support plate is also monitored. The peak load is recorded, and “E” is estimated using the above equation.

The Plate Stiffness “S” per unit width can then be calculated as:

$$S = \frac{Et^3}{12}$$

and is expressed in units of Newtons*millimeters. The Testworks program uses the following formula to calculate stiffness (or can be calculated manually from the raw data output):

$$S = \left(\frac{F}{w} \right) \left[\frac{(3+v)R^2}{16\pi} \right]$$

wherein “F/w” is max slope (force divided by deflection), “v” is Poisson's ratio taken as 0.1, and “R” is the ring radius.

The same sample stack (as used above) is then flipped upside down and retested in the same manner as previously described. This test is run three more times (with different sample stacks). Thus, eight S values are calculated from four 5-sheet stacks of the same sample. The numerical average of these eight S values is reported as Plate Stiffness for the sample.

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Stack Compressibility and Resilient Bulk Test Method:

Stack thickness (measured in mils, 0.001 inch) is measured as a function of confining pressure (g/in^2) using a Thwing-Albert (14 W. Collings Ave., West Berlin, NJ) Vantage Compression/Softness Tester (model 1750-2005 or similar) or equivalent instrument, equipped with a 2500 g load cell (force accuracy is $\pm 0.25\%$ when measuring value is between 10%-100% of load cell capacity, and 0.025% when measuring value is less than 10% of load cell capacity), a 1.128 inch diameter steel pressure foot (one square inch cross sectional area) which is aligned parallel to the steel anvil (2.5 inch diameter). The pressure foot and anvil surfaces must be clean and dust free, particularly when performing the steel-to-steel test. Thwing-Albert software (MAP) controls the motion and data acquisition of the instrument.

The instrument and software are set-up to acquire crosshead position and force data at a rate of 50 points/sec. The crosshead speed (which moves the pressure foot) for testing samples is set to 0.20 inches/min (the steel-to-steel test speed is set to 0.05 inches/min). Crosshead position and force data are recorded between the load cell range of approximately 5 and 1500 grams during compression. The crosshead is programmed to stop immediately after surpassing 1500 grams, record the thickness at this pressure (termed $T_{\max}$), and immediately reverse direction at the same speed as performed in compression. Data is collected during this decompression portion of the test (also termed recovery) between approximately 1500 and 5 grams. Since the foot area is one square inch, the force data recorded corresponds to pressure in units of g/in^2 . The MAP software is programmed to select 15 crosshead position values (for both compression and recovery) at specific pressure trap points of 10, 25, 50, 75, 100, 125, 150, 200, 300, 400, 500, 600, 750, 1000, and 1250 g/in^2 (i.e., recording the crosshead position of very next acquired data point after the each pressure point trap is surpassed). In addition to these 30 collected trap points, $T_{\max}$ is also recorded, which is the thickness at the maximum pressure applied during the test (approximately 1500 g/in^2).

Since the overall test system, including the load cell, is not perfectly rigid, a steel-to-steel test is performed (i.e., nothing in between the pressure foot and anvil) at least twice for each batch of testing, to obtain an average set of steel-to-steel crosshead positions at each of the 31 trap points described above. This steel-to-steel crosshead position data is subtracted from the corresponding

crosshead position data at each trap point for each tested stacked sample, thereby resulting in the stack thickness (mils) at each pressure trap point during the compression, maximum pressure, and recovery portions of the test.

5 $\text{StackT (trap)} = \text{StackCP (trap)} - \text{SteelCP (trap)}$

Where:

trap = trap point pressure at either compression, recovery, or max

StackT = Thickness of Stack (at trap pressure)

StackCP = Crosshead position of Stack in test (at trap pressure)

10 SteelCP = Crosshead position of steel-to-steel test (at trap pressure)

A stack of five (5) usable units thick is prepared for testing as follows. The minimum usable unit size is 2.5 inch by 2.5 inch; however a larger sheet size is preferable for testing, since it allows for easier handling without touching the central region where compression testing takes place. For typical perforated rolled bath tissue, this consists of removing five (5) sets of 3 connected usable units. In this case, testing is performed on the middle usable unit, and the outer 2 usable units are used for handling while removing from the roll and stacking. For other product formats, it is advisable, when possible, to create a test sheet size (each one usable unit thick) that is large enough such that the inner testing region of the created 5 usable unit thick stack is never physically touched, stretched, or strained, but with dimensions that do not exceed 14 inches by 6 inches.

The 5 sheets (one usable unit thick each) of the same approximate dimensions, are placed one on top the other, with their MD aligned in the same direction, their outer face all pointing in the same direction, and their edges aligned +/- 3 mm of each other. The central portion of the stack, where compression testing will take place, is never to be physically touched, stretched, and/or strained (this includes never to 'smooth out' the surface with a hand or other apparatus prior to testing).

The 5 sheet stack is placed on the anvil, positioning it such that the pressure foot will contact the central region of the stack (for the first compression test) in a physically untouched spot, leaving space for a subsequent (second) compression test, also in the central region of the stack, but separated by ¼ inch or more from the first compression test, such that both tests are in untouched, and separated spots in the central region of the stack. From these two tests, an average crosshead position of the stack at each trap pressure (i.e., StackCP(trap)) is calculated for compression,

maximum pressure, and recovery portions of the tests. Then, using the average steel-to-steel crosshead trap points (i.e., SteelCP(trap)), the average stack thickness at each trap (i.e., StackT(trap) is calculated (mils).

Stack Compressibility is defined here as the absolute value of the linear slope of the stack thickness (mils) as a function of the log(10) of the confining pressure (grams/in²), by using the 5 compression trap points discussed previously (i.e., compression from 10 to 1250 g/in²), in a least squares regression. The units for Stack Compressibility are [mils/(log(g/in²))], and is reported to the nearest 0.1 [mils/(log(g/in²))].

Resilient Bulk is calculated from the stack weight per unit area and the sum of 8 StackT(trap) thickness values from the maximum pressure and recovery portion of the tests: i.e., at maximum pressure (T_{max}) and recovery trap points at R1250, R1000, R750, R500, R300, R100, and R10 g/in² (a prefix of "R" denotes these traps come from recovery portion of the test). Stack weight per unit area is measured from the same region of the stack contacted by the compression foot, after the compression testing is complete, by cutting a 3.50 inch square (typically) with a precision die cutter, and weighing on a calibrated 3-place balance, to the nearest 0.001 gram. The 15 weight of the precisely cut stack, along with the StackT(trap) data at each required trap pressure (each point being an average from the two compression/recovery tests discussed previously), are used in the following equation to calculate Resilient Bulk, reported in units of cm³/g, to the nearest 0.1 cm³/g.

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$$\text{Resilient Bulk} = \frac{\text{SUM}(\text{StackT}(T_{\text{max}}, R1250, R1000, R750, R500, R300, R100, R10)) * 0.00254}{M/A}$$

Where:

StackT = Thickness of Stack (at trap pressures of T_{max} and recovery pressures listed above), (mils)

25 M = weight of precisely cut stack, (grams)

A = area of the precisely cut stack, (cm²)

Wet Burst Method:

"Wet Burst Strength" as used herein is a measure of the ability of a fibrous structure and/or 30 a fibrous structure product incorporating a fibrous structure to absorb energy, when wet and subjected to deformation normal to the plane of the fibrous structure and/or fibrous structure product. The Wet Burst Test is run according to ISO 12625-9:2005, except for any deviations or modifications described below.

Wet burst strength may be measured using a Thwing-Albert Burst Tester Cat. No. 177 equipped with a 2000 g load cell commercially available from Thwing-Albert Instrument Company, Philadelphia, Pa, or an equivalent instrument.

Wet burst strength is measured by preparing four (4) multi-ply fibrous structure product samples for testing. First, condition the samples for two (2) hours at a temperature of 73° F $\pm$ 2° F (23° C $\pm$ 1° C) and a relative humidity of 50% ($\pm$ 2%). Take one sample and horizontally dip the center of the sample into a pan filled with about 25 mm of room temperature distilled water. Leave the sample in the water four (4) ($\pm$ 0.5) seconds. Remove and drain for three (3) ($\pm$ 0.5) seconds holding the sample vertically so the water runs off in the cross-machine direction. Proceed with the test immediately after the drain step.

Place the wet sample on the lower ring of the sample holding device of the Burst Tester with the outer surface of the sample facing up so that the wet part of the sample completely covers the open surface of the sample holding ring. If wrinkles are present, discard the samples and repeat with a new sample. After the sample is properly in place on the lower sample holding ring, turn the switch that lowers the upper ring on the Burst Tester. The sample to be tested is now securely gripped in the sample holding unit. Start the burst test immediately at this point by pressing the start button on the Burst Tester. A plunger will begin to rise (or lower) toward the wet surface of the sample. At the point when the sample tears or ruptures, report the maximum reading. The plunger will automatically reverse and return to its original starting position. Repeat this procedure on three (3) more samples for a total of four (4) tests, i.e., four (4) replicates. Report the results as an average of the four (4) replicates, to the nearest gram.

Wet Tensile Method:

Wet Elongation, Tensile Strength, and TEA are measured on a constant rate of extension tensile tester with computer interface (a suitable instrument is the EJA Vantage from the Thwing-Albert Instrument Co. West Berlin, NJ) using a load cell for which the forces measured are within 10% to 90% of the limit of the load cell. Both the movable (upper) and stationary (lower) pneumatic jaws are fitted with smooth stainless steel faced grips, with a design suitable for testing 1 inch wide sheet material (Thwing-Albert item #733GC). An air pressure of about 60 psi is supplied to the jaws.

Eight usable units of fibrous structures are divided into two stacks of four usable units each. The usable units in each stack are consistently oriented with respect to machine direction (MD) and cross direction (CD). One of the stacks is designated for testing in the MD and the other for

CD. Using a one inch precision cutter (Thwing Albert) take a CD stack and cut one, $1.00 \text{ in} \pm 0.01$ in wide by at least 3.0 in long stack of strips (long dimension in CD). In like fashion cut the remaining stack in the MD (strip long dimension in MD), to give a total of 8 specimens, four CD and four MD strips. Each strip to be tested is one usable unit thick, and will be treated as a unitary specimen for testing.

Program the tensile tester to perform an extension test (described below), collecting force and extension data at an acquisition rate of 100 Hz as the crosshead raises at a rate of 2.00 in/min (10.16 cm/min) until the specimen breaks. The break sensitivity is set to 50%, i.e., the test is terminated when the measured force drops below 50% of the maximum peak force, after which the crosshead is returned to its original position.

Set the gage length to 2.00 inches. Zero the crosshead and load cell. Insert the specimen into the upper and lower open grips such that at least 0.5 inches of specimen length is contained each grip. Align the specimen vertically within the upper and lower jaws, then close the upper grip. Verify the specimen is hanging freely and aligned with the lower grip, then close the lower grip. Initiate the first portion of the test, which pulls the specimen at a rate of 0.5 in/min, then stops immediately after a load of 10 grams is achieved. Using a pipet, thoroughly wet the specimen with DI water to the point where excess water can be seen pooling on the top of the lower closed grip. Immediately after achieving this wetting status, initiate the second portion of the test, which pulls the wetted strip at 2.0 in/min until break status is achieved. Repeat testing in like fashion for all four CD and four MD specimens.

Program the software to calculate the following from the constructed force (g) verses extension (in) curve:

Wet Tensile Strength (g/in) is the maximum peak force (g) divided by the specimen width (1 in), and reported as g/in to the nearest 0.1 g/in.

Adjusted Gage Length (in) is calculated as the extension measured (from original 2.00 inch gage length) at 3 g of force during the test following the wetting of the specimen (or the next data point after 3 g force) added to the original gage length (in). If the load does not fall below 3 g force during the wetting procedure, then the adjusted gage length will be the extension measured at the point the test is resumed following wetting added to the original gage length (in).

Wet Peak Elongation (%) is calculated as the additional extension (in) from the Adjusted Gage Length (in) at the maximum peak force point (more specifically, at the last maximum peak force point, if there is more than one) divided by the Adjusted Gage Length (in) multiplied by 100 and reported as % to the nearest 0.1 %.

Wet Peak Tensile Energy Absorption (TEA, $\text{g}\cdot\text{in}/\text{in}^2$) is calculated as the area under the force curve ($\text{g}\cdot\text{in}^2$) integrated from zero extension (i.e., the Adjusted Gage Length) to the extension at the maximum peak force elongation point (more specifically, at the last maximum peak force point, if there is more than one) (in), divided by the product of the adjusted Gage Length (in) and specimen width (in). This is reported as $\text{g}\cdot\text{in}/\text{in}^2$ to the nearest $0.01 \text{ g}\cdot\text{in}/\text{in}^2$.

The Wet Tensile Strength (g/in), Wet Peak Elongation (%), Wet Peak TEA ($\text{g}\cdot\text{in}/\text{in}^2$) are calculated for the four CD specimens and the four MD specimens. Calculate an average for each parameter separately for the CD and MD specimens.

10 Calculations

Geometric Mean Initial Wet Tensile Strength = Square Root of [MD Wet Tensile Strength (g/in) x CD Wet Tensile Strength (g/in)]

Geometric Mean Wet Peak Elongation = Square Root of [MD Wet Peak Elongation (%) x CD Wet Peak Elongation (%)]

15 Geometric Mean Wet Peak TEA = Square Root of [MD Wet Peak TEA ($\text{g}\cdot\text{in}/\text{in}^2$) x CD Wet Peak TEA ($\text{g}\cdot\text{in}/\text{in}^2$)]

Total Wet Tensile (TWT) = MD Wet Tensile Strength (g/in) + CD Wet Tensile Strength (g/in)

Total Wet Peak TEA = MD Wet Peak TEA ($\text{g}\cdot\text{in}/\text{in}^2$) + CD Wet Peak TEA ($\text{g}\cdot\text{in}/\text{in}^2$)

20 Wet Tensile Ratio = MD Wet Peak Tensile Strength (g/in) / CD Wet Peak Tensile Strength (g/in)

Wet Tensile Geometric Mean (GM) Modulus = Square Root of [MD Modulus (at 38 g/cm) x CD Modulus (at 38 g/cm)]

25 This method is typically used for sanitary tissue products in the form of a paper towel. In the present application, unless the term “Finch” or “Finch cup” is coupled with wet tensile terminology, this is the method being referred to. If “Finch” or “Finch cup” is coupled with wet tensile terminology, the Finch Cup Wet Tensile Test Method should be referred to.

30 Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Toilet Paper (for Paper Towels, use: “Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Paper Towels;” for Facial Tissue, use: “Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Facial Tissue”):

Elongation, Tensile Strength, TEA and Tangent Modulus are measured on a constant rate of extension tensile tester with computer interface (a suitable instrument is the EJA Vantage from the Thwing-Albert Instrument Co. Wet Berlin, NJ) using a load cell for which the forces measured are within 10% to 90% of the limit of the load cell. Both the movable (upper) and stationary (lower) pneumatic jaws are fitted with smooth stainless steel faced grips, with a design suitable for testing 1 inch wide sheet material (Thwing-Albert item #733GC). An air pressure of about 60 psi is supplied to the jaws.

Twenty usable units of fibrous structures are divided into four stacks of five usable units each. The usable units in each stack are consistently oriented with respect to machine direction (MD) and cross direction (CD). Two of the stacks are designated for testing in the MD and two for CD. Using a one inch precision cutter (Thwing Albert) take a CD stack and cut two, 1.00 in $\pm$ 0.01 in wide by at least 3.0 in long strips from each CD stack (long dimension in CD). Each strip is five usable unit layers thick and will be treated as a unitary specimen for testing. In like fashion cut the remaining CD stack and the two MD stacks (long dimension in MD) to give a total of 8 specimens (five layers each), four CD and four MD.

Program the tensile tester to perform an extension test, collecting force and extension data at an acquisition rate of 20 Hz as the crosshead raises at a rate of 4.00 in/min (10.16 cm/min) until the specimen breaks. The break sensitivity is set to 50%, i.e., the test is terminated when the measured force drops to 50% of the maximum peak force, after which the crosshead is returned to its original position.

Set the gage length to 2.00 inches. Zero the crosshead and load cell. Insert the specimen into the upper and lower open grips such that at least 0.5 inches of specimen length is contained each grip. Align specimen vertically within the upper and lower jaws, then close the upper grip. Verify specimen is aligned, then close lower grip. The specimen should be under enough tension to eliminate any slack, but less than 0.05 N of force measured on the load cell. Start the tensile tester and data collection. Repeat testing in like fashion for all four CD and four MD specimens.

Program the software to calculate the following from the constructed force (g) verses extension (in) curve:

Tensile Strength is the maximum peak force (g) divided by the product of the specimen width (1 in) and the number of usable units in the specimen (5), and then reported as g/in to the nearest 1 g/in.

Adjusted Gage Length is calculated as the extension measured at 11.12 g of force (in) added to the original gage length (in).

Elongation is calculated as the extension at maximum peak force (in) divided by the Adjusted Gage Length (in) multiplied by 100 and reported as % to the nearest 0.1 %.

Tensile Energy Absorption (TEA) is calculated as the area under the force curve integrated from zero extension to the extension at the maximum peak force (g*in), divided by the product of the adjusted Gage Length (in), specimen width (in), and number of usable units in the specimen (5). This is reported as g*in/in² to the nearest 1 g*in/in².

Replot the force (g) verses extension (in) curve as a force (g) verses strain curve. Strain is herein defined as the extension (in) divided by the Adjusted Gage Length (in).

Program the software to calculate the following from the constructed force (g) verses strain curve:

Tangent Modulus is calculated as the least squares linear regression using the first data point from the force (g) verses strain curve recorded after 190.5 g (38.1 g x 5 layers) force and the 5 data points immediately preceding and the 5 data points immediately following it. This slope is then divided by the product of the specimen width (2.54 cm) and the number of usable units in the specimen (5), and then reported to the nearest 1 g/cm.

The Tensile Strength (g/in), Elongation (%), TEA (g*in/in²) and Tangent Modulus (g/cm) are calculated for the four CD specimens and the four MD specimens. Calculate an average for each parameter separately for the CD and MD specimens.

20 Calculations

Geometric Mean Tensile = Square Root of [MD Tensile Strength (g/in) x CD Tensile Strength (g/in)]

Geometric Mean Peak Elongation = Square Root of [MD Elongation (%) x CD Elongation (%)]

25 Geometric Mean TEA = Square Root of [MD TEA (g*in/in²) x CD TEA (g*in/in²)]

Geometric Mean Modulus = Square Root of [MD Modulus (g/cm) x CD Modulus (g/cm)]

Total Dry Tensile Strength (TDT) = MD Tensile Strength (g/in) + CD Tensile Strength (g/in)

Total TEA = MD TEA (g*in/in²) + CD TEA (g*in/in²)

Total Modulus = MD Modulus (g/cm) + CD Modulus (g/cm)

30 Tensile Ratio = MD Tensile Strength (g/in) / CD Tensile Strength (g/in)

Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Facial Tissue (for Paper Towels, use: "Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Paper

Towels;” for Toilet Paper, use: “Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Toilet Paper”):

Elongation, Tensile Strength, TEA and Tangent Modulus are measured on a constant rate of extension tensile tester with computer interface (a suitable instrument is the EJA Vantage from the Thwing-Albert Instrument Co. Wet Berlin, NJ) using a load cell for which the forces measured are within 10% to 90% of the limit of the load cell. Both the movable (upper) and stationary (lower) pneumatic jaws are fitted with smooth stainless steel faced grips, with a design suitable for testing 1 inch wide sheet material (Thwing-Albert item #733GC). An air pressure of about 60 psi is supplied to the jaws.

Eight usable units of fibrous structures are divided into two stacks of four usable units each. The usable units in each stack are consistently oriented with respect to machine direction (MD) and cross direction (CD). One of the stacks is designated for testing in the MD and the other for CD. Using a one inch precision cutter (Thwing Albert) take a CD stack and cut one, 1.00 in $\pm$ 0.01 in wide by at least 5.0 in long stack of strips (long dimension in CD). In like fashion cut the remaining stack in the MD (strip long dimension in MD), to give a total of 8 specimens, four CD and four MD strips. Each strip to be tested is one usable unit thick, and will be treated as a unitary specimen for testing.

Program the tensile tester to perform an extension test, collecting force and extension data at an acquisition rate of 20 Hz as the crosshead raises at a rate of 6.00 in/min (15.24 cm/min) until the specimen breaks. The break sensitivity is set to 50%, i.e., the test is terminated when the measured force drops to 50% of the maximum peak force, after which the crosshead is returned to its original position.

Set the gage length to 4.00 inches. Zero the crosshead and load cell. Insert the specimen into the upper and lower open grips such that at least 0.5 inches of specimen length is contained each grip. Align specimen vertically within the upper and lower jaws, then close the upper grip. Verify specimen is aligned, then close lower grip. The specimen should be under enough tension to eliminate any slack, but less than 0.05 N of force measured on the load cell. Start the tensile tester and data collection. Repeat testing in like fashion for all four CD and four MD specimens.

Program the software to calculate the following from the constructed force (g) verses extension (in) curve:

Tensile Strength is the maximum peak force (g) divided by the specimen width (1 in), and reported as g/in to the nearest 1 g/in.

Adjusted Gage Length is calculated as the extension measured at 11.12 g of force (in) added to the original gage length (in).

Elongation is calculated as the extension at maximum peak force (in) divided by the Adjusted Gage Length (in) multiplied by 100 and reported as % to the nearest 0.1 %.

5 **Tensile Energy Absorption (TEA)** is calculated as the area under the force curve integrated from zero extension to the extension at the maximum peak force (g*in), divided by the product of the adjusted Gage Length (in) and specimen width (in). This is reported as g*in/in² to the nearest 1 g*in/in².

10 Replot the force (g) verses extension (in) curve as a force (g) verses strain curve. Strain is herein defined as the extension (in) divided by the Adjusted Gage Length (in).

Program the software to calculate the following from the constructed force (g) verses strain curve:

15 **Tangent Modulus** is calculated as the least squares linear regression using the first data point from the force (g) verses strain curve recorded after 38.1 g force and the 5 data points immediately preceding and the 5 data points immediately following it. This slope is then divided by the specimen width (2.54 cm), and then reported to the nearest 1 g/cm.

The Tensile Strength (g/in), Elongation (%), TEA (g*in/in²) and Tangent Modulus (g/cm) are calculated for the four CD specimens and the four MD specimens. Calculate an average for each parameter separately for the CD and MD specimens.

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Calculations

Geometric Mean Tensile = Square Root of [MD Tensile Strength (g/in) x CD Tensile Strength (g/in)]

25 Geometric Mean Peak Elongation = Square Root of [MD Elongation (%) x CD Elongation (%)]

Geometric Mean TEA = Square Root of [MD TEA (g*in/in²) x CD TEA (g*in/in²)]

Geometric Mean Modulus = Square Root of [MD Modulus (g/cm) x CD Modulus (g/cm)]

Total Dry Tensile Strength (TDT) = MD Tensile Strength (g/in) + CD Tensile Strength (g/in)

Total TEA = MD TEA (g*in/in²) + CD TEA (g*in/in²)

30 Total Modulus = MD Modulus (g/cm) + CD Modulus (g/cm)

Tensile Ratio = MD Tensile Strength (g/in) / CD Tensile Strength (g/in)

Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Paper Towels (for Facial Tissue, use: “Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Facial Tissue;” for Toilet Paper, use: “Dry Elongation, Tensile Strength, TEA and Modulus Test Methods for Toilet Paper”):

5 Elongation, Tensile Strength, TEA and Tangent Modulus are measured on a constant rate of extension tensile tester with computer interface (a suitable instrument is the EJA Vantage from the Thwing-Albert Instrument Co. Wet Berlin, NJ) using a load cell for which the forces measured are within 10% to 90% of the limit of the load cell. Both the movable (upper) and stationary (lower) pneumatic jaws are fitted with smooth stainless steel faced grips, with a design
10 suitable for testing 1 inch wide sheet material (Thwing-Albert item #733GC). An air pressure of about 60 psi is supplied to the jaws.

 Eight usable units of fibrous structures are divided into two stacks of four usable units each. The usable units in each stack are consistently oriented with respect to machine direction (MD) and cross direction (CD). One of the stacks is designated for testing in the MD and the other for
15 CD. Using a one inch precision cutter (Thwing Albert) take a CD stack and cut one, 1.00 in $\pm$ 0.01 in wide by at least 5.0 in long stack of strips (long dimension in CD). In like fashion cut the remaining stack in the MD (strip long dimension in MD), to give a total of 8 specimens, four CD and four MD strips. Each strip to be tested is one usable unit thick, and will be treated as a unitary specimen for testing.

20 Program the tensile tester to perform an extension test, collecting force and extension data at an acquisition rate of 20 Hz as the crosshead raises at a rate of 4.00 in/min (10.16 cm/min) until the specimen breaks. The break sensitivity is set to 50%, i.e., the test is terminated when the measured force drops to 50% of the maximum peak force, after which the crosshead is returned to its original position.

25 Set the gage length to 4.00 inches. Zero the crosshead and load cell. Insert the specimen into the upper and lower open grips such that at least 0.5 inches of specimen length is contained each grip. Align specimen vertically within the upper and lower jaws, then close the upper grip. Verify specimen is aligned, then close lower grip. The specimen should be under enough tension to eliminate any slack, but less than 0.05 N of force measured on the load cell. Start the tensile
30 tester and data collection. Repeat testing in like fashion for all four CD and four MD specimens.

 Program the software to calculate the following from the constructed force (g) verses extension (in) curve:

Tensile Strength is the maximum peak force (g) divided by the specimen width (1 in), and reported as g/in to the nearest 1 g/in.

Adjusted Gage Length is calculated as the extension measured at 11.12 g of force (in) added to the original gage length (in).

5 **Elongation** is calculated as the extension at maximum peak force (in) divided by the Adjusted Gage Length (in) multiplied by 100 and reported as % to the nearest 0.1 %.

10 **Tensile Energy Absorption (TEA)** is calculated as the area under the force curve integrated from zero extension to the extension at the maximum peak force (g*in), divided by the product of the adjusted Gage Length (in) and specimen width (in). This is reported as g*in/in² to the nearest 1 g*in/in².

Replot the force (g) verses extension (in) curve as a force (g) verses strain curve. Strain is herein defined as the extension (in) divided by the Adjusted Gage Length (in).

Program the software to calculate the following from the constructed force (g) verses strain curve:

15 **Tangent Modulus** is calculated as the least squares linear regression using the first data point from the force (g) verses strain curve recorded after 38.1 g force and the 5 data points immediately preceding and the 5 data points immediately following it. This slope is then divided by the specimen width (2.54 cm), and then reported to the nearest 1 g/cm.

20 The Tensile Strength (g/in), Elongation (%), TEA (g*in/in²) and Tangent Modulus (g/cm) are calculated for the four CD specimens and the four MD specimens. Calculate an average for each parameter separately for the CD and MD specimens.

Calculations

25 Geometric Mean Tensile = Square Root of [MD Tensile Strength (g/in) x CD Tensile Strength (g/in)]

Geometric Mean Peak Elongation = Square Root of [MD Elongation (%) x CD Elongation (%)]

Geometric Mean TEA = Square Root of [MD TEA (g*in/in²) x CD TEA (g*in/in²)]

Geometric Mean Modulus = Square Root of [MD Modulus (g/cm) x CD Modulus (g/cm)]

30 Total Dry Tensile Strength (TDT) = MD Tensile Strength (g/in) + CD Tensile Strength (g/in)

Total TEA = MD TEA (g*in/in²) + CD TEA (g*in/in²)

Total Modulus = MD Modulus (g/cm) + CD Modulus (g/cm)

Tensile Ratio = MD Tensile Strength (g/in) / CD Tensile Strength (g/in)

Flexural Rigidity Method:

This test is based on the cantilever beam principle. A Cantilever Bending Tester such as described in ASTM Standard D1388 is used to measure the distance a strip of sample can be
5 extended beyond a horizontal flat platform before it bends to a ramp angle of $41.5 \pm 0.5^\circ$. The measured Bend Length, in addition to the Basis Weight and Caliper, of the sample is used to calculate Flexural Rigidity.

Using a 1 inch (2.54 cm) JDC Cutter (available from Thwing-Albert Instrument Company, Philadelphia, PA), carefully cut eight (8) 1 inch (2.54 cm) wide test strips from a fibrous structure
10 sample oriented in the MD direction. From a second fibrous structure sample from the same sample set, carefully cut eight (8) 1 inch (2.54 cm) wide strips of the fibrous structure in the CD direction.

The sample strip must be adjusted to 4.0 ± 0.1 in (101.5 ± 2.5 mm), or 6.0 ± 0.1 in (152 ± 2.5 mm) in length. Towel samples and those products which are perforated into usable units 6
15 inches (152mm) or greater in both dimensions without folds or perforations are tested as 6 in (152mm) strips. Toilet tissue samples and facial tissue samples are tested as 4 in (101.5mm) long strips. To adjust the strips to length, carefully make a cut exactly perpendicular to the long dimension of the strip near one end using a paper cutter. It is important that the cut be exactly perpendicular to the long dimension of the strip. Make a second cut exactly 4.0 ± 0.1 in (101.5mm),
20 or 6.0 ± 0.1 in (152 ± 2.5 mm) along the strip, again being careful that the cut is exactly perpendicular to the long dimension of the strip. In the case of perforated or folded products, be sure that all cuts are made in such a way that perforations and/or folds are excluded from the 4.0 (101.5mm) or 6.0 in (152mm) strip which will be used for the test. All sample strips should be cut individually with minimal mechanical manipulation. No fibrous structure sample which is creased,
25 bent, folded, perforated, or in any other way weakened should be tested using this test.

Mark the direction (MD or CD) very lightly on one end of the strip, keeping the same surface of the sample up for all strips. Later, half of the strips will be turned over for testing, thus it is important that one surface of the strip be clearly identified, however, it makes no difference which surface of the sample is designated as the upper surface.

30 Using other portions of the fibrous structure sample (not the cut strips), determine the basis weight of the fibrous structure sample in lbs/3000 ft² and the caliper of the fibrous structure in mils (thousandths of an inch) using the standard procedures disclosed herein. Place the Cantilever Bending Tester level on a bench or table that is relatively free of vibration, excessive heat and most

importantly air drafts. Adjust the platform of the Tester to horizontal as indicated by the leveling bubble and verify that the ramp angle is at $41.5 \pm 0.5^\circ$. Remove the sample slide bar from the top of the platform of the Tester. Lay one of the strips flat on the horizontal platform using care to align the strip to be parallel with the movable sample slide. Align the end of the strip exactly even with the vertical edge of the Tester where the angular ramp is attached or where the zero mark line is scribed on the Tester. Carefully place the sample slide bar on top of the sample strip in the Tester. The sample slide bar must be carefully placed so that the strip is not wrinkled or moved from its initial position.

Using the sample slide bar, move the strip at a rate of approximately 0.5 ± 0.2 in/second (1.3 ± 0.5 cm/second) toward the end of the Tester to which the angular ramp is attached. This can be accomplished with either a manual or automatic Tester. Ensure that no slippage between the strip and movable sample slide occurs. As the sample slide bar and strip project over the edge of the Tester, the strip will begin to bend, or drape downward. Stop moving the sample slide bar the instant the leading edge of the strip falls level with the ramp edge. Read and record the overhang length from the linear scale to the nearest 0.5 mm. Record the distance the sample slide bar has moved in cm as overhang length. This test sequence is performed a total of eight (8) times for each fibrous structure in each direction (MD and CD). The first four strips are tested with the upper surface as the fibrous structure was cut facing up. The last four strips are inverted so that the upper surface as the fibrous structure was cut is facing down as the strip is placed on the horizontal platform of the Tester.

The average Overhang Lengths (MD, CD, and Avg) and Bend Lengths (MD, CD, and Avg) are determined by the following calculations:

$$\text{Overhang Length MD} = \frac{\text{Sum of 8 MD readings}}{8}$$

$$\text{Overhang Length CD} = \frac{\text{Sum of 8 CD readings}}{8}$$

$$\text{Overhang Length Average (Avg)} = \frac{\text{Sum of all 16 readings}}{16}$$

$$\text{Bend Length MD} = \frac{\text{Overhang Length MD}}{2}$$

$$\text{Bend Length CD} = \frac{\text{Overhang Length CD}}{2}$$

$$\text{Bend Length Average (Avg)} = \frac{\text{Overhang Length Total}}{2}$$

$$\text{Flexural Rigidity} = 0.1629 \times W \times C^3$$

Where W is the basis weight of the fibrous structure in lbs/3000 ft²; C is the Bend Length (MD, CD, or Avg) in cm; and the constant 0.1629 is used to convert the basis weight from English to metric units. The results are expressed in mg-cm to the nearest 0.1 mg-cm.

5 GM Flexural Rigidity = Square root of (MD Flexural Rigidity x CD Flexural Rigidity)

CRT Rate and Capacity Method:

CRT Rate and Capacity values are generated by running the test procedure as defined in U.S. Patent Application No. US 2017-0183824.

10

Dry and Wet Caliper Test Methods:

Dry and Wet Caliper values are generated by running the test procedure as defined in U.S. Patent No. US 7,744,723 and states, in relevant part:

15 Dry Caliper Method:

Samples are conditioned at 23+/-1° C. and 50%+/-2% relative humidity for two hours prior to testing.

Dry Caliper of a sample of fibrous structure product is determined by cutting a sample of the fibrous structure product such that it is larger in size than a load foot loading surface where the load foot loading surface has a circular surface area of about 3.14 in². The sample is confined between a horizontal flat surface and the load foot loading surface. The load foot loading surface applies a confining pressure to the sample of 14.7 g/cm² (about 0.21 psi). The caliper is the resulting gap between the flat surface and the load foot loading surface. Such measurements can be obtained on a VIR Electronic Thickness Tester Model II available from Thwing-Albert Instrument Company, Philadelphia, Pa. The caliper measurement is repeated and recorded at least five (5) times so that an average caliper can be calculated. The result is reported in mils.

25

Wet Caliper Method:

30 Samples are conditioned at 23+/-1° C. and 50% relative humidity for two hours prior to testing.

Wet Caliper of a sample of fibrous structure product is determined by cutting a sample of the fibrous structure product such that it is larger in size than a load foot loading surface where the load foot loading surface has a circular surface area of about 3.14 in². Each sample is wetted by submerging the sample in a distilled water bath for 30 seconds. The caliper of the wet sample is

measured within 30 seconds of removing the sample from the bath. The sample is then confined between a horizontal flat surface and the load foot loading surface. The load foot loading surface applies a confining pressure to the sample of 14.7 g/cm^2 (about 0.21 psi). The caliper is the resulting gap between the flat surface and the load foot loading surface. Such measurements can be obtained on a VIR Electronic Thickness Tester Model II available from Thwing-Albert Instrument Company, Philadelphia, Pa. The caliper measurement is repeated and recorded at least five (5) times so that an average caliper can be calculated. The result is reported in mils.

Finch Cup Wet Tensile Test Method:

The Wet Tensile Strength test method is utilized for the determination of the wet tensile strength of a sanitary tissue product or web strip after soaking with water, using a tensile-strength-testing apparatus operating with a constant rate of elongation. The Wet Tensile Strength test is run according to ISO 12625-5:2005, except for any deviations or modifications described below. This method uses a vertical tensile-strength tester, in which a device that is held in the lower grip of the tensile-strength tester, called a Finch Cup, is used to achieve the wetting.

Using a one inch JDC precision sample cutter (Thwing Albert) cut six $1.00 \text{ in} \pm 0.01 \text{ in}$ wide strips from a sanitary tissue product sheet or web sheet in the machine direction (MD), and six strips in the cross machine direction (CD). An electronic tensile tester (Model 1122, Instron Corp., or equivalent) is used and operated at a crosshead speed of 1.0 inch (about 1.3 cm) per minute and a gauge length of 1.0 inch (about 2.5 cm). The two ends of the strip are placed in the upper jaws of the machine, and the center of the strip is placed around a stainless steel peg. The strip is soaked in distilled water at about 20° C . for the identified soak time, and then measured for peak tensile strength. Reference to a machine direction means that the sample being tested is prepared such that the length of the strip is cut parallel to the machine direction of manufacture of the product.

The MD and CD wet peak tensile strengths are determined using the above equipment and calculations in the conventional manner. The reported value is the arithmetic average of the six strips tested for each directional strength to the nearest 0.1 grams force. The total wet tensile strength for a given soak time is the arithmetic total of the MD and CD tensile strengths for that soak time. Initial total wet tensile strength ("ITWT") is measured when the paper has been submerged for 5 ± 0.5 seconds. Decayed total wet tensile ("DTWT") is measured after the paper has been submerged for 30 ± 0.5 minutes.

This method is typically used for sanitary tissue products in the form of toilet (or bath) tissue.

Wet Decay Test Method:

5 Wet decay (loss of wet tensile) for a sanitary tissue product or web is measured according to the Wet Tensile Test Method described herein and is the wet tensile of the sanitary tissue product or web after it has been standing in the soaked condition in the Finch Cup for 30 minutes. Wet decay is reported in units of “%”. Wet decay is the % loss of Initial Total Wet Tensile after the 30 minute soaking.

10

Dry Burst (“Dry Burst Strength” or “Dry Burst (Peak Load) Strength”) Test Method:

The Dry Burst Test is run according to ISO 12625-9:2005, except for any deviations described below. Sanitary tissue product samples or web samples for each condition to be tested are cut to a size appropriate for testing, a minimum of five (5) samples for each condition to be tested are prepared.

15 A burst tester (Burst Tester Intellect-II-STD Tensile Test Instrument, Cat. No. 1451-24PGB available from Thwing-Albert Instrument Co., Philadelphia, Pa., or equivalent) is set up according to the manufacturer's instructions and the following conditions: Speed: 12.7 centimeters per minute; Break Sensitivity: 20 grams; and Peak Load: 2000 grams. The load cell is calibrated according to the expected burst strength.

20 A sanitary tissue product sample or web sample to be tested is clamped and held between the annular clamps of the burst tester and is subjected to increasing force that is applied by a 0.625 inch diameter, polished stainless steel ball upon operation of the burst tester according to the manufacturer's instructions. The burst strength is that force that causes the sample to fail.

25 The burst strength for each sanitary tissue product sample or web sample is recorded. An average and a standard deviation for the burst strength for each condition is calculated.

The Dry Burst is reported as the average and standard deviation for each condition to the nearest gram.

30 Residual Water (R_w) Test Method:

This method measures the amount of distilled water absorbed by a paper product. In general a finite amount of distilled water is deposited to a standard surface. A paper towel is then placed over the water for a given amount of time. After the elapsed time the towel is removed and the amount of water left behind and amount of water absorbed are calculated.

The temperature and humidity are controlled within the following limits:

- Temperature: $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$. ($73^{\circ}\text{F} \pm 2^{\circ}\text{F}$.)
- Relative humidity: $50\% \pm 2\%$

The following equipment is used in this test method. A top loading balance is used with
5 sensitivity: ± 0.01 grams or better having the capacity of grams minimum. A pipette is used having
a capacity of 5 mL and a Sensitivity ± 1 mL. A Formica™ Tile 6 in $\times$ 7 in is used. A stop watch or
digital timer capable of measuring time in seconds to the nearest 0.1 seconds is also used.

Sample and Solution Preparation

For this test method, distilled water is used, controlled to a temperature of $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$.
10 ($73^{\circ}\text{F} \pm 2^{\circ}\text{F}$.). For this method, a usable unit is described as one finished product unit regardless
of the number of plies. Condition the rolls or usable units of products, with wrapper or packaging
materials removed in a room conditioned at $50\% \pm 2\%$ relative humidity, $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$. ($73^{\circ}\text{F} \pm 2^{\circ}\text{F}$.)
for a minimum of two hours. Do not test usable units with defects such as wrinkles, tears,
holes etc.

15 Paper Samples

Remove and discard at least the four outermost usable units from the roll. For testing
remove usable units from each roll of product submitted as indicated below. For Paper Towel
products, select five (5) usable units from the roll. For Paper Napkins that are folded, cut and
stacked, select five (5) usable units from the sample stack submitted for testing. For all napkins,
20 either double or triple folded, unfold the usable units to their largest square state. One-ply
napkins will have one 1-ply layer; 2-ply napkins will have one 2-ply layer. With 2-ply napkins,
the plies may be either embossed (just pressed) together, or embossed and laminated (pressed and
glued) together. Care must be taken when unfolding 2-ply usable units to keep the plies together.
If the unfolded usable unit dimensions exceed 279 mm (11 inches) in either direction, cut the
25 usable unit down to 279 mm (11 inches). Record the original usable unit size if over 279 mm (11
inches). If the unfolded usable unit dimensions are less than 279 mm (11 inches) in either
direction, record the usable unit dimensions.

Place the Formica Tile (standard surface) in the center of the cleaned balance surface.
Wipe the Formica Tile to ensure that it is dry and free of any debris. Tare the balance to get a
30 zero reading. Slowly dispense 2.5 mL of distilled water onto the center of the standard surface
using the pipette. Record the weight of the water to the nearest 0.001 g. Drop 1 usable unit of the
paper towel onto the spot of water with the outside ply down. Immediately start the stop watch.
The sample should be dropped on the spot such that the spot is in the center of the sample once it

is dropped. Allow the paper towel to absorb the distilled water for 30 seconds after hitting the stop watch. Remove the paper from the spot after the 30 seconds has elapsed. The towel must be removed when the stop watch reads 30 seconds $\pm$ 0.1 sec. The paper towel should be removed using a quick vertical motion. Record the weight of the remaining water on the surface to the nearest 0.001 g.t

Calculations

where:

n=the number of replicates which for this method is 5.

Record the RWV to the nearest 0.001 g.

Breaking Length Test Method:

Handsheet Preparation

Low Density handsheets are made essentially according to TAPPI standard T205, with the following modifications which are believed to more accurately reflect the tissue manufacturing process.

(1) tap water, with no pH adjustment, is used;

(2) the embryonic web is formed in a 12 in. by 12 in. handsheet making apparatus on a monofilament polyester wire supplied by Appelon Wire Co., Appelon, Wis. with the following specifications:

Size:	13.5 inch $\times$ 13.5 inch
Machine direction Warp Count:	84 1.5 fibers/inch
Cross direction Warp Count:	76 $\pm$ 3.0 fibers/inch
Warp size/type:	0.17 millimeters/9FU
Shute size/type:	0.17 millimeters/WVP-110
Caliper:	0.016 $\pm$ 0.0005 inch
Air permeability:	720 $\pm$ 25 cubic feet/minute

(3) the embryonic web is transferred by vacuum from the monofilament polyester wire to a monofilament polyester papermaking fabric supplied by Appelon Wire Co., Appelon, Wis. and dewatered by vacuum suction instead of pressing; Fabric specifications:

Size:	16 inch × 14 inch
Machine direction Warp Count:	36 ± 1 fibers/inch
Cross direction Warp Count:	30 ± 3 fibers/inch
Warp size/type: Shute size/type:	0.40 millimeters/WVP-87-12A-W
0.40 millimeters/WP-801-12A-W	
Caliper:	0.0270 ± 0.001 inch
Air permeability:	397 ± 25 cubic feet/minute

Sheet side to be monoplane

Transfer and dewatering details: The embryonic web and papermaking wire are placed on top of the fabric such that the embryonic web contacts the fabric. The trilayer (wire, web, fabric with fabric side down) is then passed lengthwise across a 13 in. × 1/16 in. wide vacuum slot box with a 90 degree flare set at a peak gauge reading of approximately 4.0 in. of mercury vacuum. The rate of the trilayer passing across the vacuum slot should be uniform at a velocity of 16±5 in./sec.

The vacuum is then increased to achieve a peak gauge reading of approximately 9 in. of mercury vacuum and the trilayer is passed lengthwise across the same vacuum slot at the same rate of 16±5 in./sec 2 more times. Note that the peak gauge reading is the amount of vacuum measured as the trilayer passes across the slot. The web is carefully removed from the wire to ensure that no fibers stick to the wire.

(4) the sheet is then dried on a rotary drum drier with a drying felt by passing the web and fabric between the felt and drum with the fabric against the drum surface and again with a second pass with the web against the drum surface.

15

Dryer specifications:	Stainless steel polished finish cylinder with internal steam heating, horizontally mounted.
External dimensions:	17 inches length × 13 inches diameter
Temperature:	230 ± 5 degrees Fahrenheit.
Rotation speed:	0.90 ± 0.05 revolutions/minute
Dryer felt: Endless, 80 inches circumference by 16 inches	wide, No. 11614, style X225, all wool. Noble and Wood Lab Machine Company, Hoosick Falls, NY.
Felt tension:	As low and even as possible without any slippage occurring between the felt and dryer drum and uniform tracking.

(5) the resulting handsheet is 12 in. × 12 in. with a resulting target basis weight of 16.5 ± 1.5 pounds per 3,000 ft² and a target density of 0.15 ± 0.06 g/cc, unless otherwise noted.

20

Sample Preparation

Condition the handsheet to be tested for a minimum of 2 hours in a room controlled to 73° F ± 2° F (23° C ± 1° C) 50 ± 2% relative humidity. After conditioning the handsheet for at least the minimum time period, measure and record the Basis Weight of the handsheet. The Basis Weight should be within the range 15.0 – 18.0 pounds per 3000 square feet, if the Basis Weight of the handsheet falls outside of this range the handsheet should be discarded and a new one made. From the handsheet, cut eight sample strips 1.00 inch wide and at least 6 - 7 inches long in the cross direction (only) using a precision 1” cutter or an appropriate die.

Measurement

Using an electronic tensile tester (Thwing Albert EJA or Intellect II-STD, Corp., Philadelphia, Pa., or equivalent) measure the Tensile Strength of each of the eight sample strips. To perform the test, set the gage length to 4.00 inches, properly secure the sample strip into the upper and lower grips, and perform an extension test, collecting force and extension data as the crosshead raises at a rate of 0.5 in/min until the sample breaks. The resulting Tensile Strength values for each of the eight individual sample strips are recorded in g/in. The Tensile Strength is the maximum peak force (g) divided by the specimen width (1 in), and reported as g/in to the nearest 1 g/in.

Calculations

Calculate the Average Tensile Strength of the eight test strips using the following formula:

$$\text{Average Tensile Strength} = \frac{\text{Sum of tensile strengths measured}}{\text{number of strips tested}}$$

Basis weight corrected tensile (BWCT) is calculated via the following formula:

$$BWCT = \text{Average Tensile Strength} \times \frac{10.5}{(\text{Basis Weight} - 6.0)}$$

Where Basis Weight has the units of pounds per 3000 ft² and Average Tensile Strength and BWCT have the units of g/in. This equation has the effect of normalizing the strength of the tensile strip to a standard 16.5 pound/3000 ft² weight when the handsheet is in the specified 15-18 pound/3000 ft² range.

Breaking Length is then calculated by the following formula:

$$\text{Breaking Length} = BWCT \times 1.4673$$

5

Where Breaking Length has the units of meters reported to the nearest whole meter.

Tear Strength Test Method (“CD Tear,” “MD Tear,” and “GM Tear”)

The Tear Strength Test Method is run according to TAPPI T414 om-12 “Internal tearing
 10 resistance of paper (Elmendorf-type method)” with the following specifications and/or
 distinctions: Testing is performed on a Thwing-Albert Model 60-100 (available from Thwing-
 Albert Instrument Company, Philadelphia, USA) Elmendorf type tearing tester, or appropriate
 equivalent. Testing is performed on ten (10) replicate test specimens in both the Machine Direction
 (MD) and Cross Direction (CD). For testing of a finished product, eight usable units (also termed
 15 sheets) are removed, cut to size, and appropriately stacked together to form the test specimen
 regardless of the number of plies. The usable units are selected to avoid defects, perforations,
 creases or folds. When eight usable units are tested, the equation for calculation of average tearing
 force in section 8.6.1 is modified to have the “number of plies” value replaced with “number of
 usable units”, which would be eight (8) regardless of the number of plies. In addition to the
 20 calculation of the average tearing force in both the MD and CD, calculate the Geometric Mean
 (GM) Tear Value, in units of grams force (gf), according to the following equation:

GM Tear Value (gf)

$$= \sqrt[2]{MD \text{ Average Tearing Force (gf)} \times CD \text{ Average Tearing Force (gf)}}$$

25 REGARDING THE PRESENT DISCLOSURE

In the interests of brevity and conciseness, any ranges of values set forth in this
 specification are to be construed as written description support for Claims reciting any sub-
 ranges having endpoints which are whole number values within the specified range in question.
 By way of a hypothetical illustrative example, a disclosure in this specification of a range of 1-5
 30 shall be considered to support Claims to any of the following sub-ranges: 1-4; 1-3; 1-2; 2-5; 2-4;
 2-3; 3-5; 3-4; and 4-5.

The dimensions and values disclosed herein in this application are not to be understood as
 being strictly limited to the exact numerical values recited. Instead, unless otherwise specified,

each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as “40 mm” is intended to mean “about 40 mm.”

5 Every document cited herein, including any cross referenced or related patent or application is hereby incorporated herein by reference in its entirety unless expressly excluded or otherwise limited. The citation of any document is not an admission that it is prior art with respect to any example disclosed or claimed herein or that it alone, or in any combination with any other reference or references, teaches, suggests or discloses any such example. Further, to the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of the
10 same term in a document incorporated by reference, the meaning or definition assigned to that term in this document shall govern.

While particular examples of the present disclosure have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the present disclosure. It is therefore intended
15 to cover in the appended Claims all such changes and modifications that are within the scope of this disclosure.

CLAIMS

What is Claimed is:

1. A sanitary tissue product, comprising:
a web comprising at least about 85% short fibers; and
wherein the web is creped and is at least one of structured and through air dried.
2. The sanitary tissue product of claim 1, wherein the web is structured and through air dried.
3. The sanitary tissue product of claim 1, wherein the web comprises a first zone having a first density and a second zone having a second density, wherein the first and second zones are at least about 30% different.
4. The sanitary tissue product of claim 1, comprising a VFS greater than about 10 g/g.
5. The sanitary tissue product of claim 1, comprising a caliper greater than about 20 mils.
6. The sanitary tissue product of claim 1, comprising a GM Dry Modulus less than about 1000 g/cm.
7. The sanitary tissue product of claim 1, wherein the web comprises a nonwood.
8. The sanitary tissue product of claim 1, wherein the web comprises jute.
9. The sanitary tissue product of claim 1, comprising a TS7 less than about 12 dB V² rms.
10. The sanitary tissue product of claim 1, comprising a slip stick of less than about 500 dB V² rms.

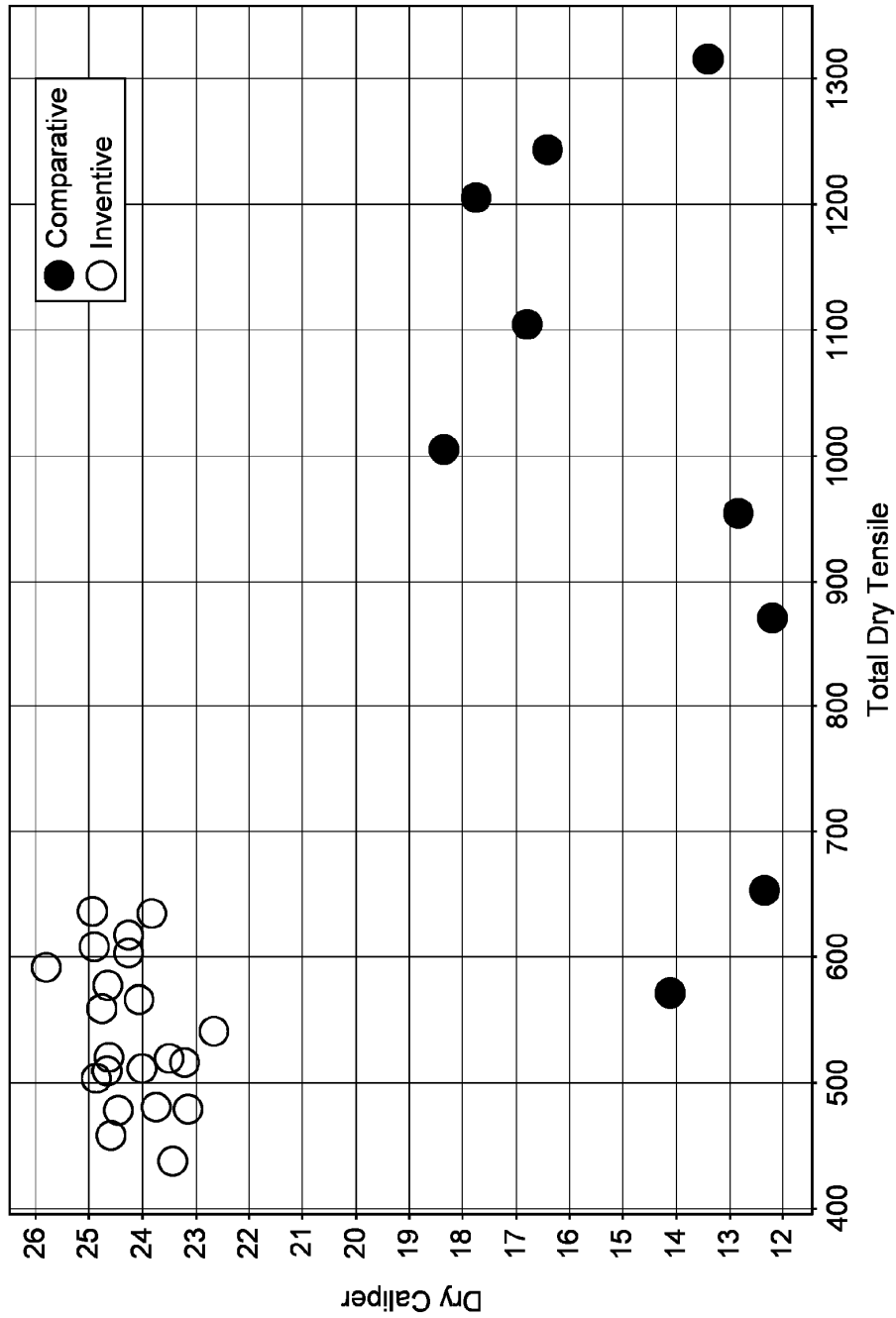


FIG. 1A

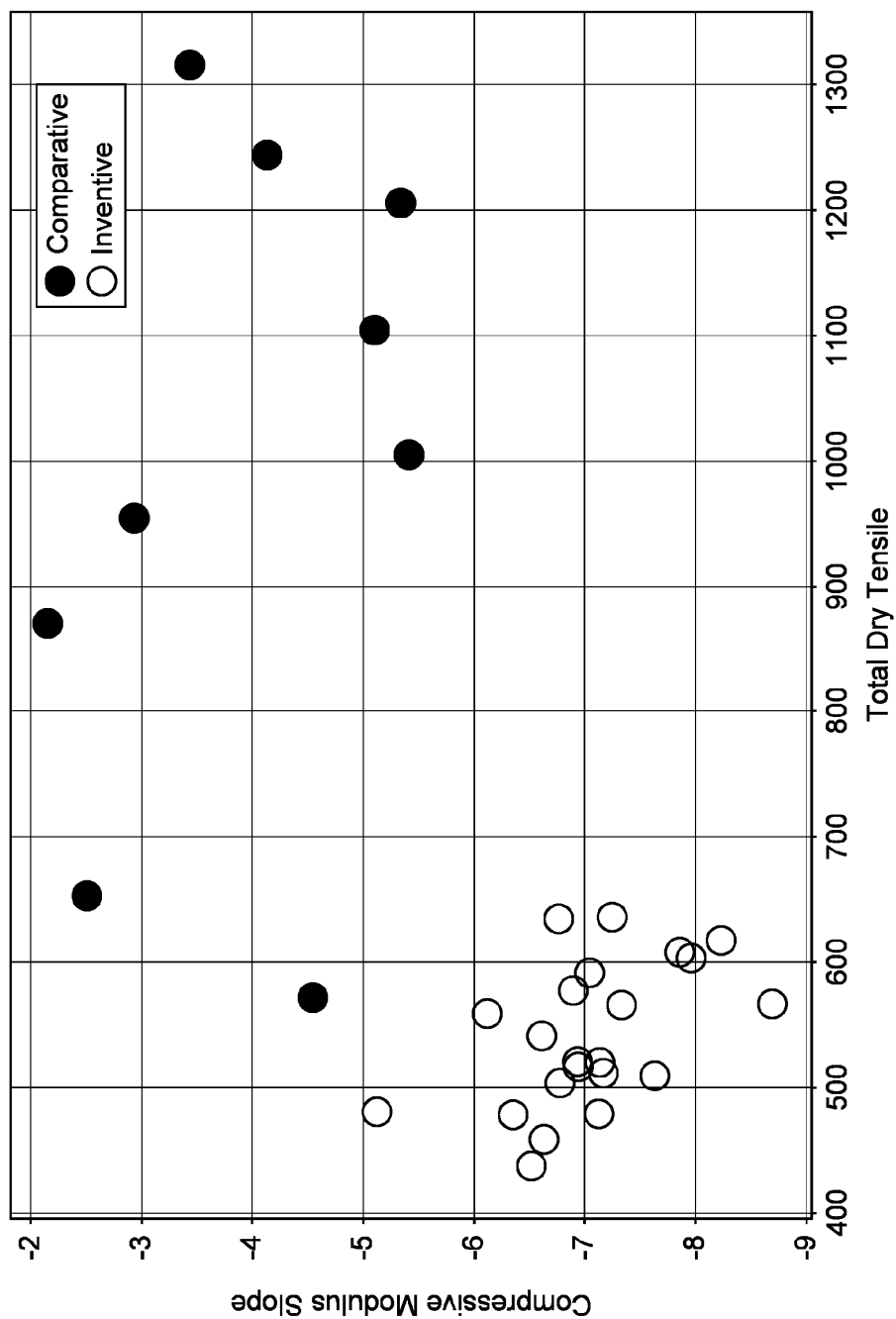


FIG. 1B

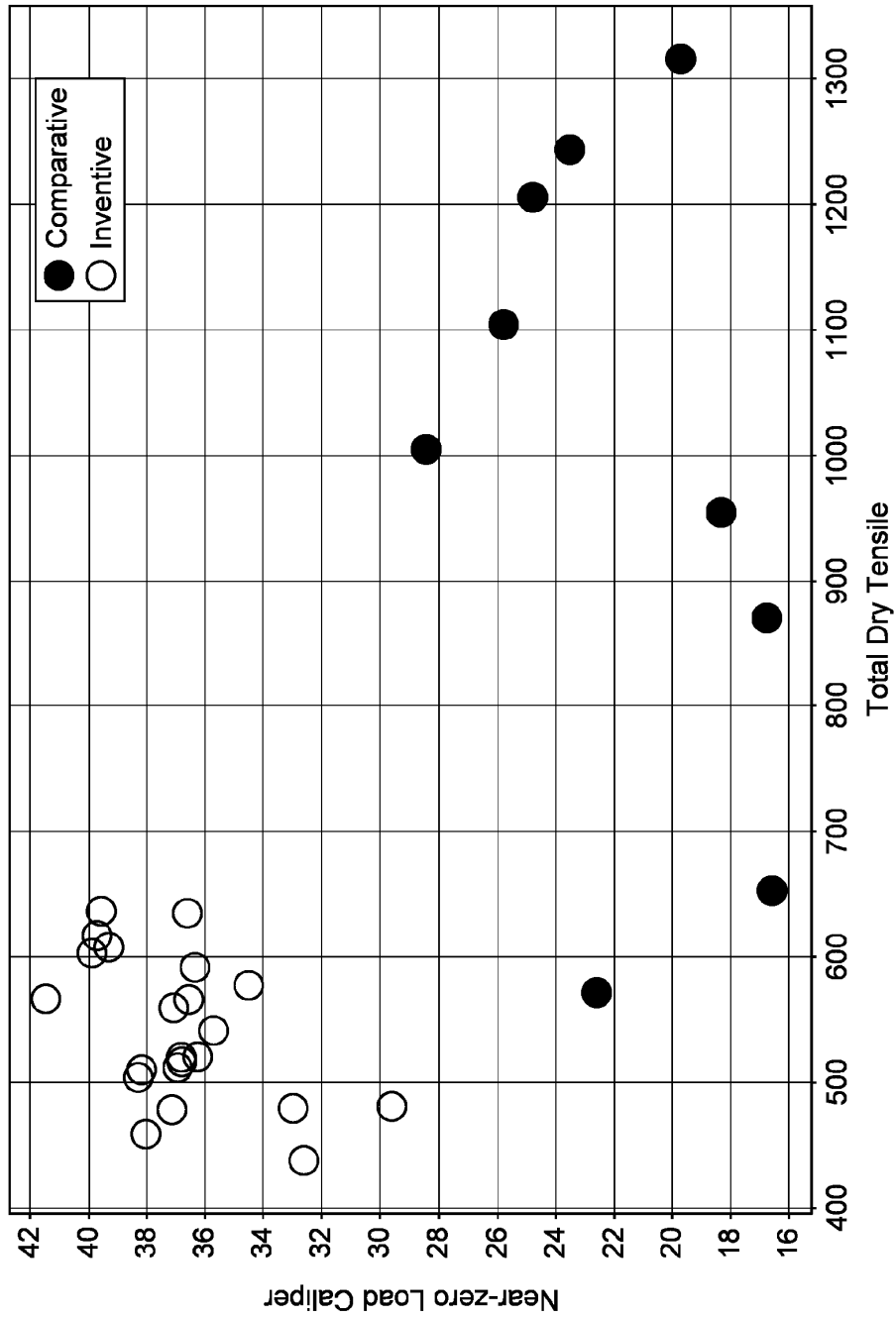


FIG. 1C

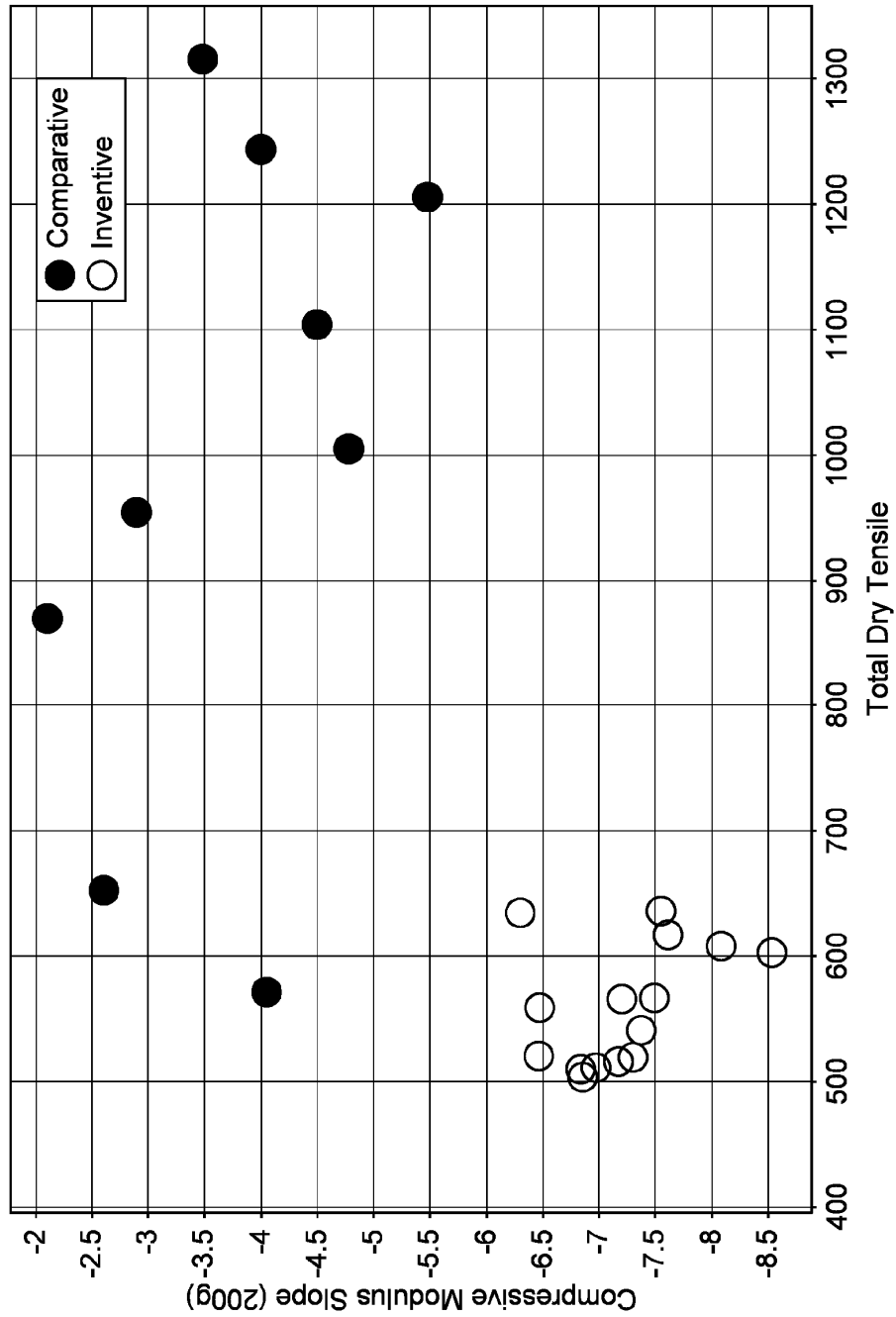


FIG. 1D

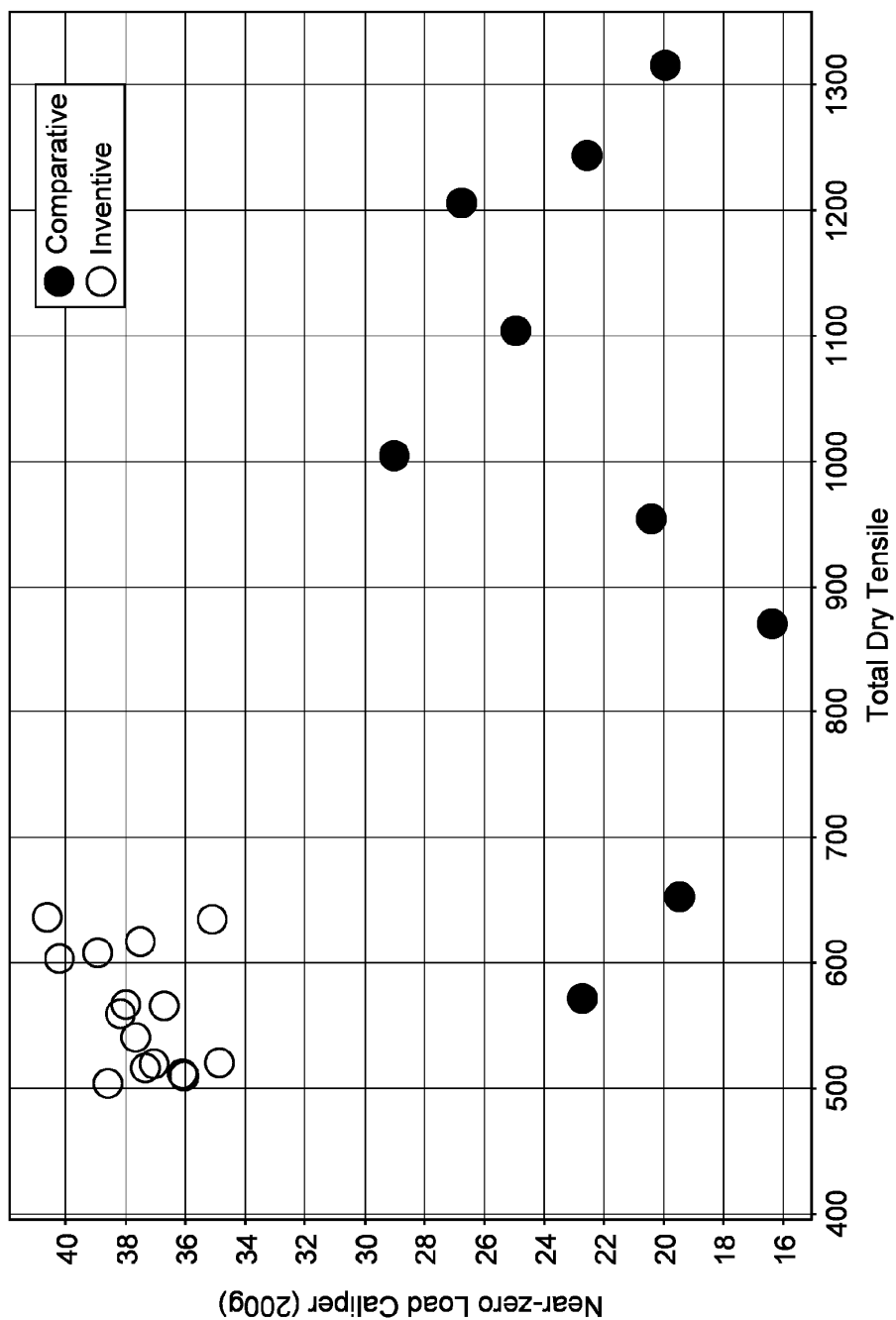


FIG. 1E

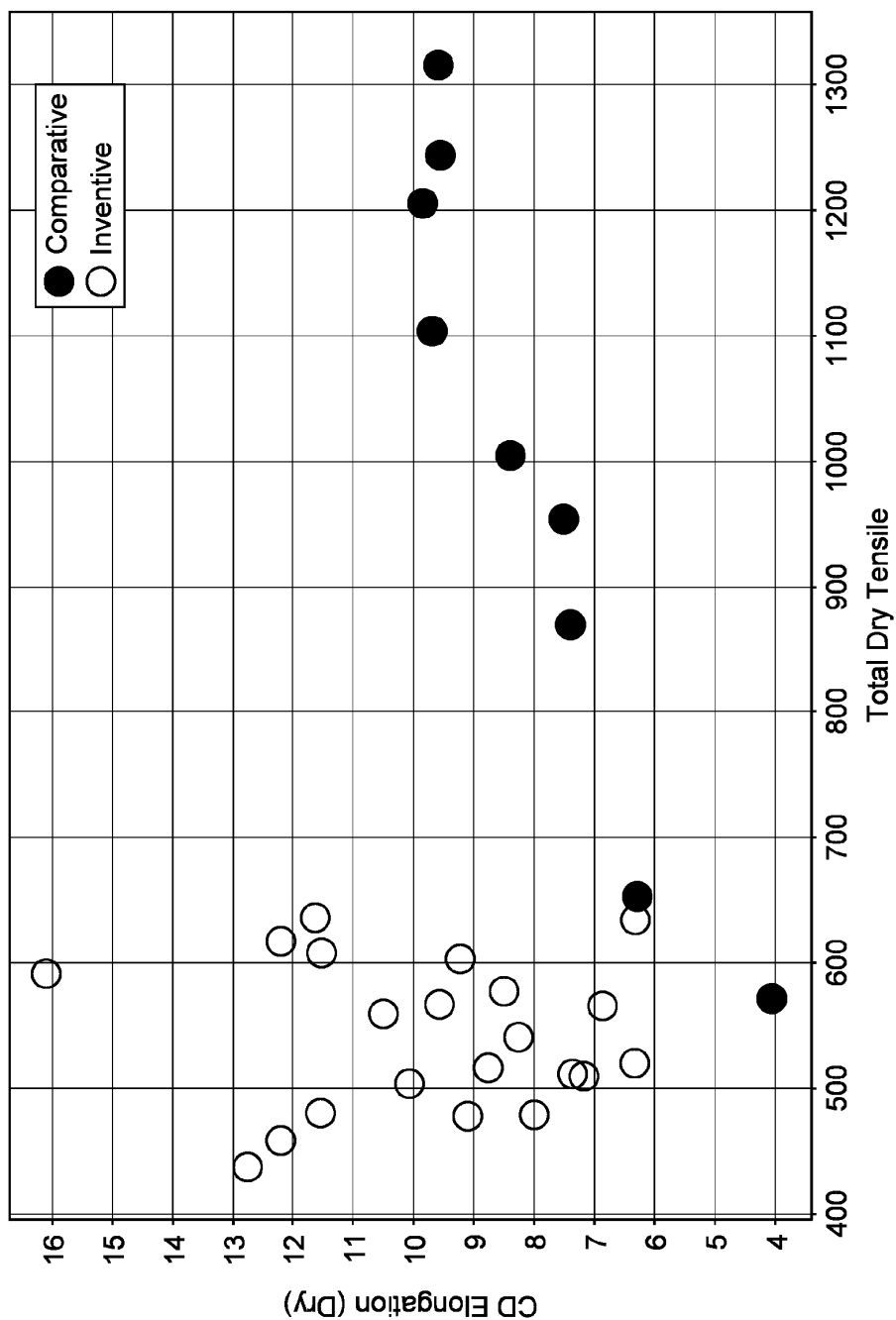


FIG. 1F

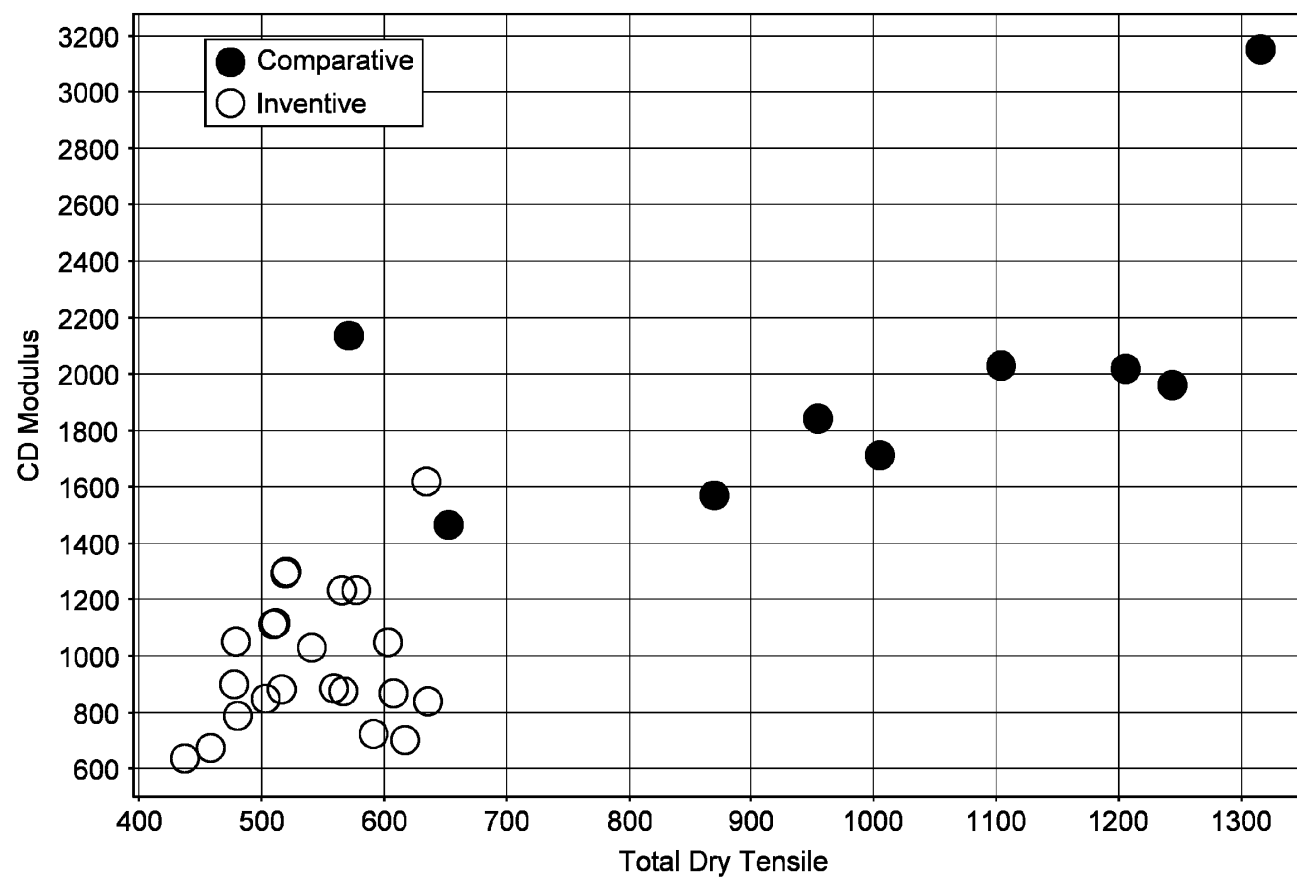


FIG. 1G

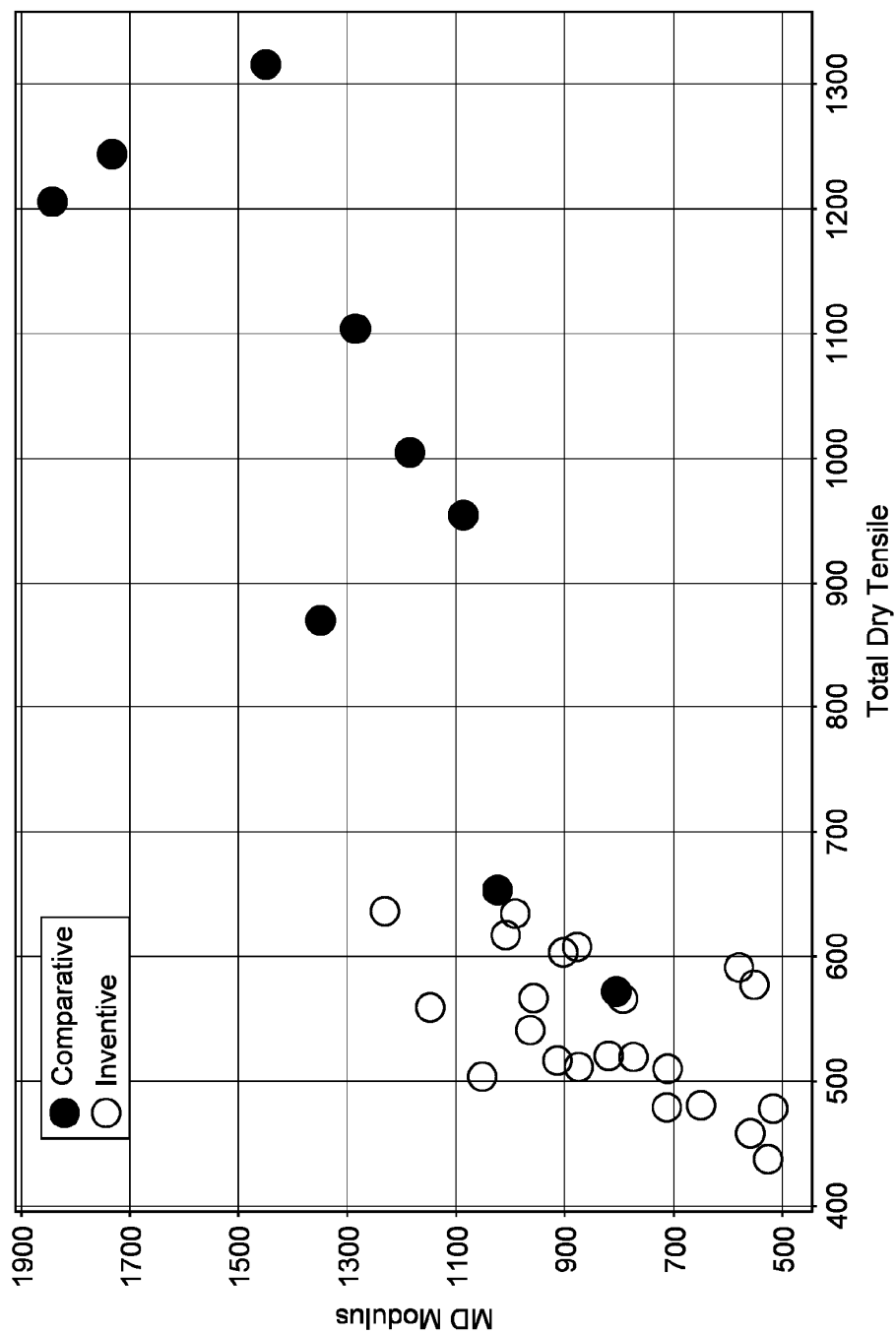


FIG. 1H

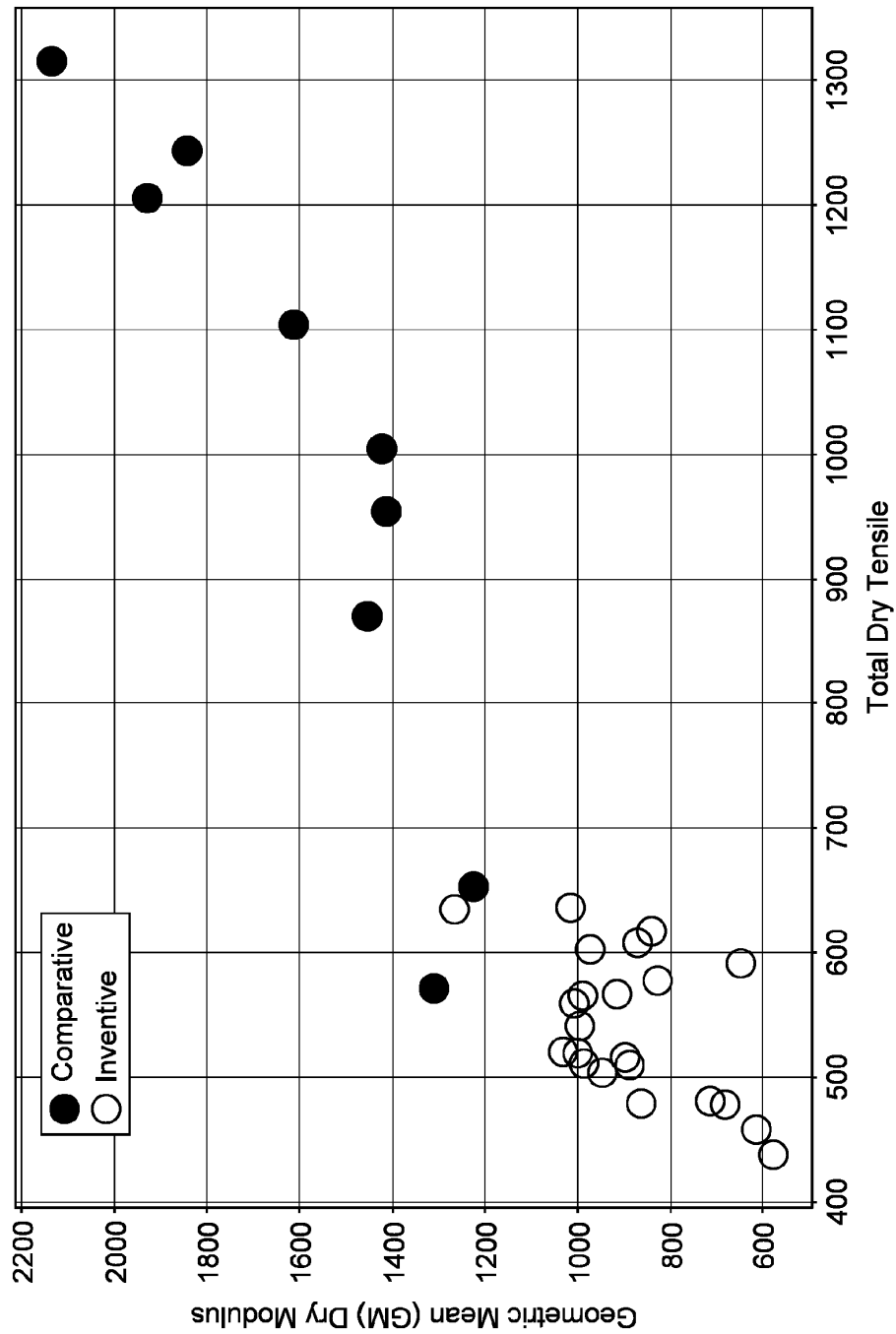


FIG. 1I

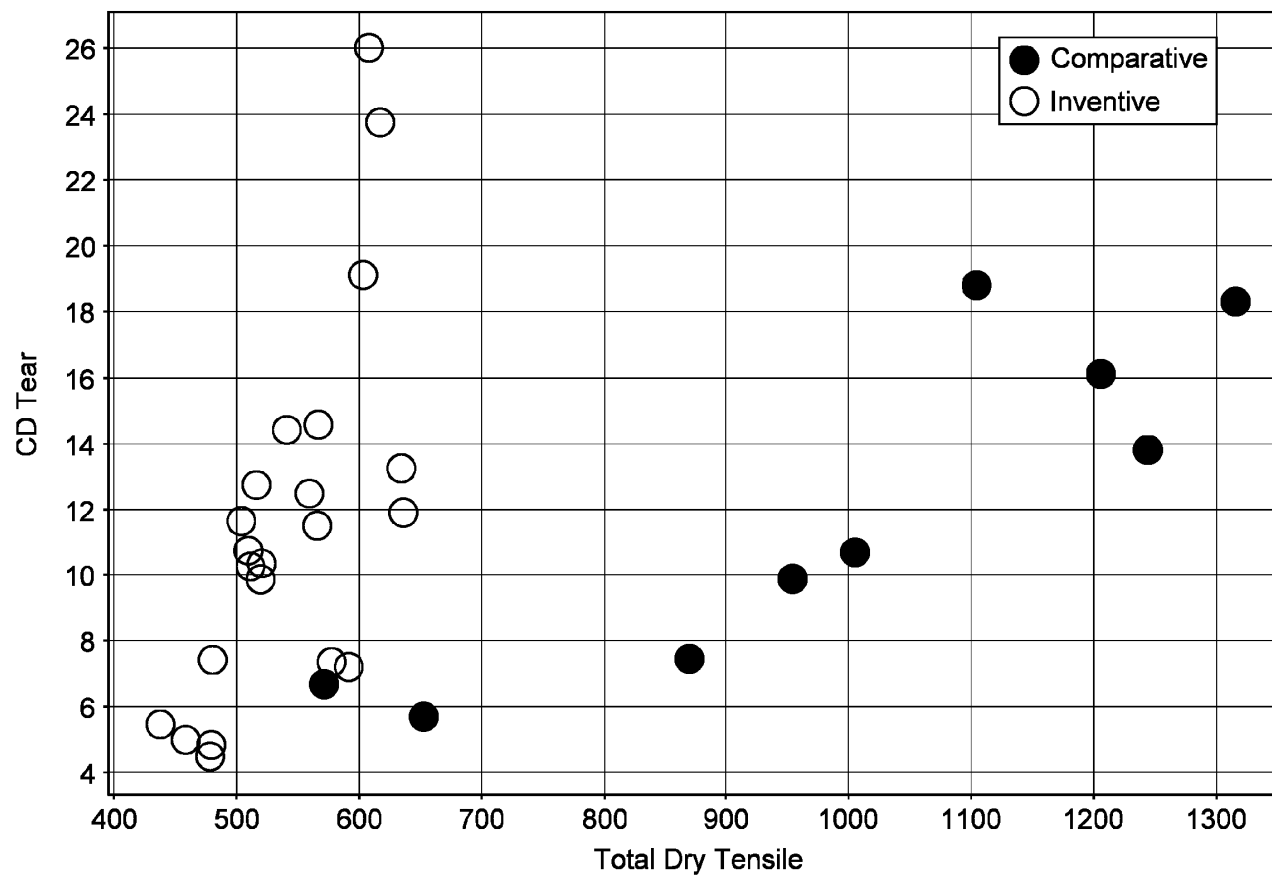
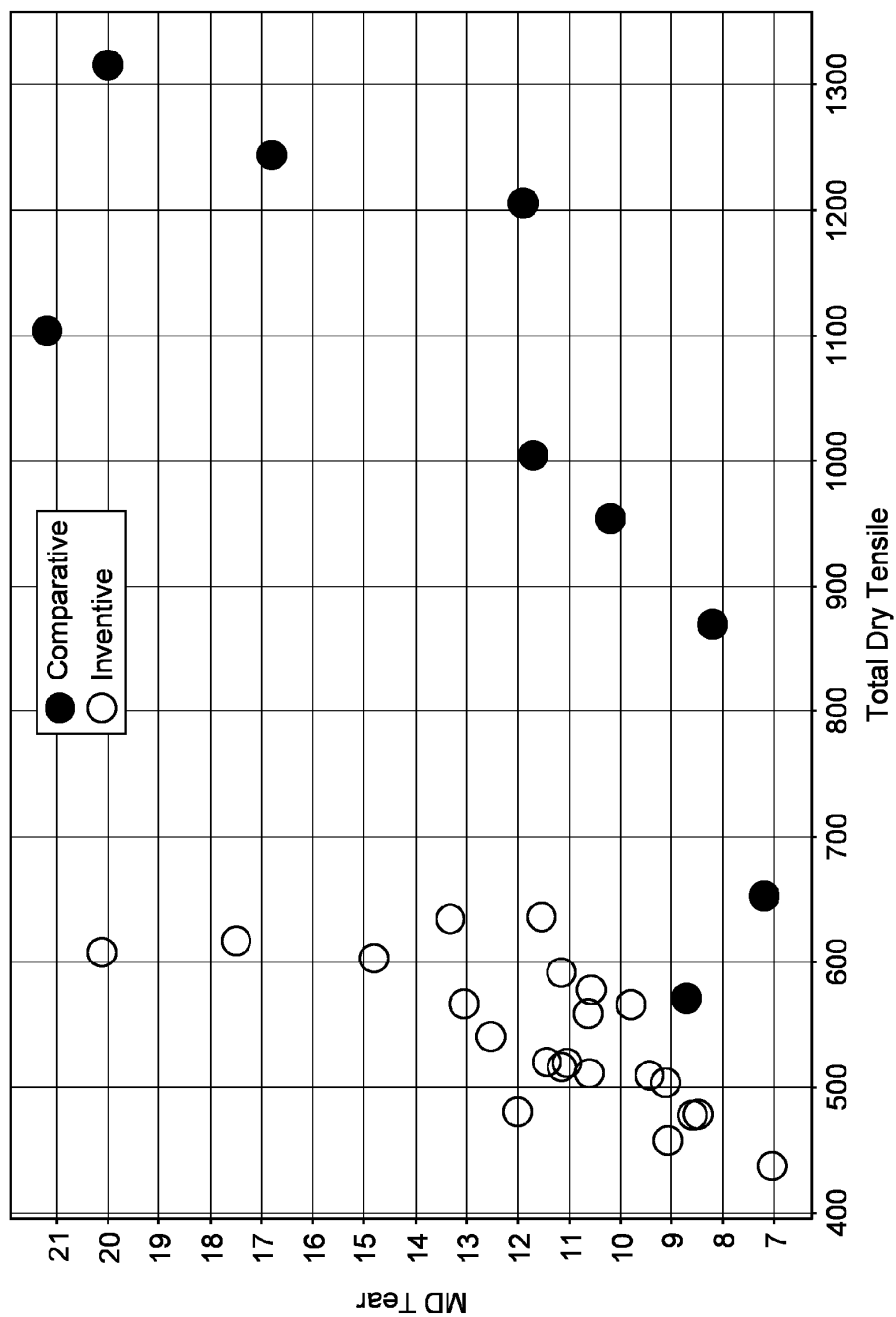


FIG. 1J



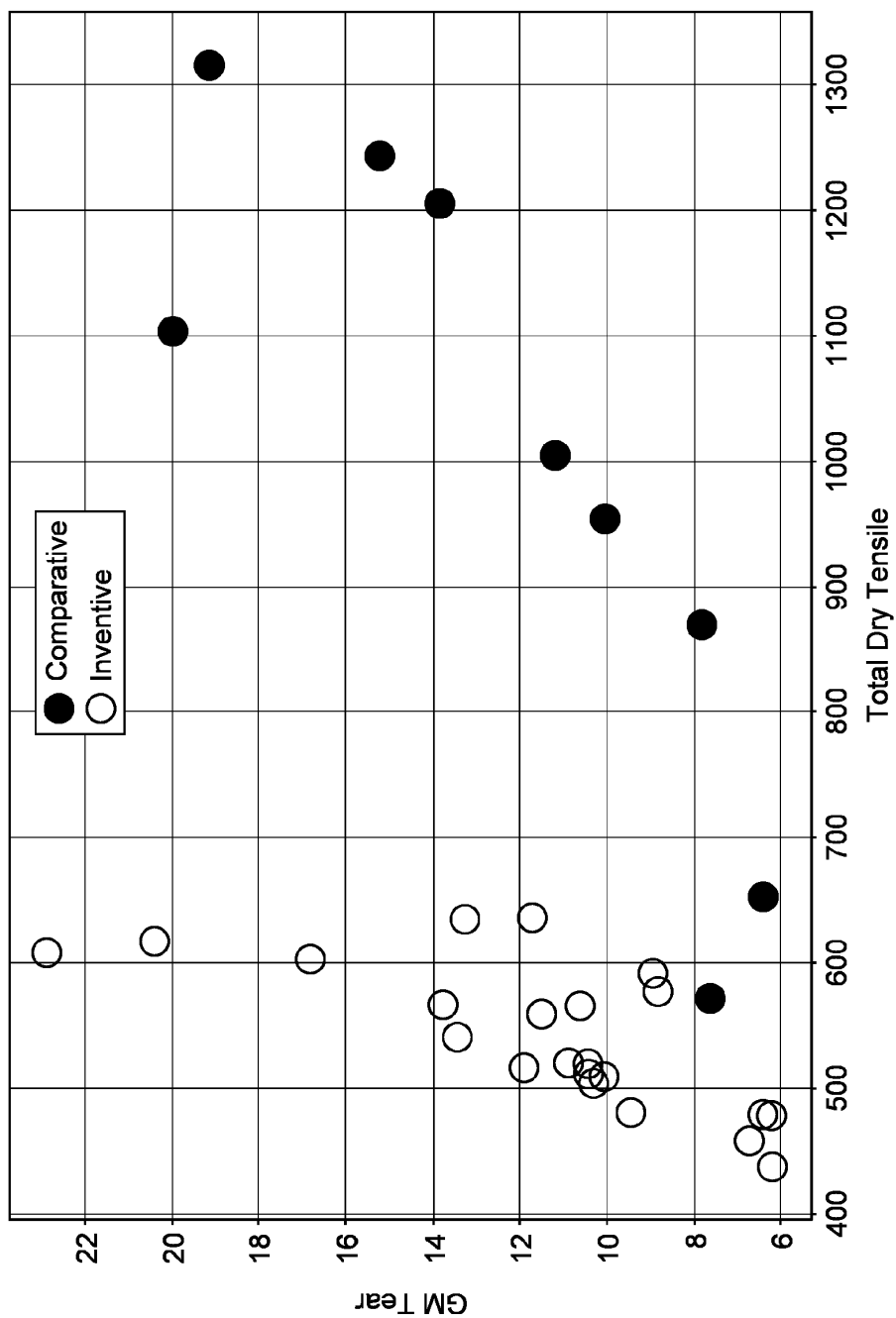


FIG. 1L

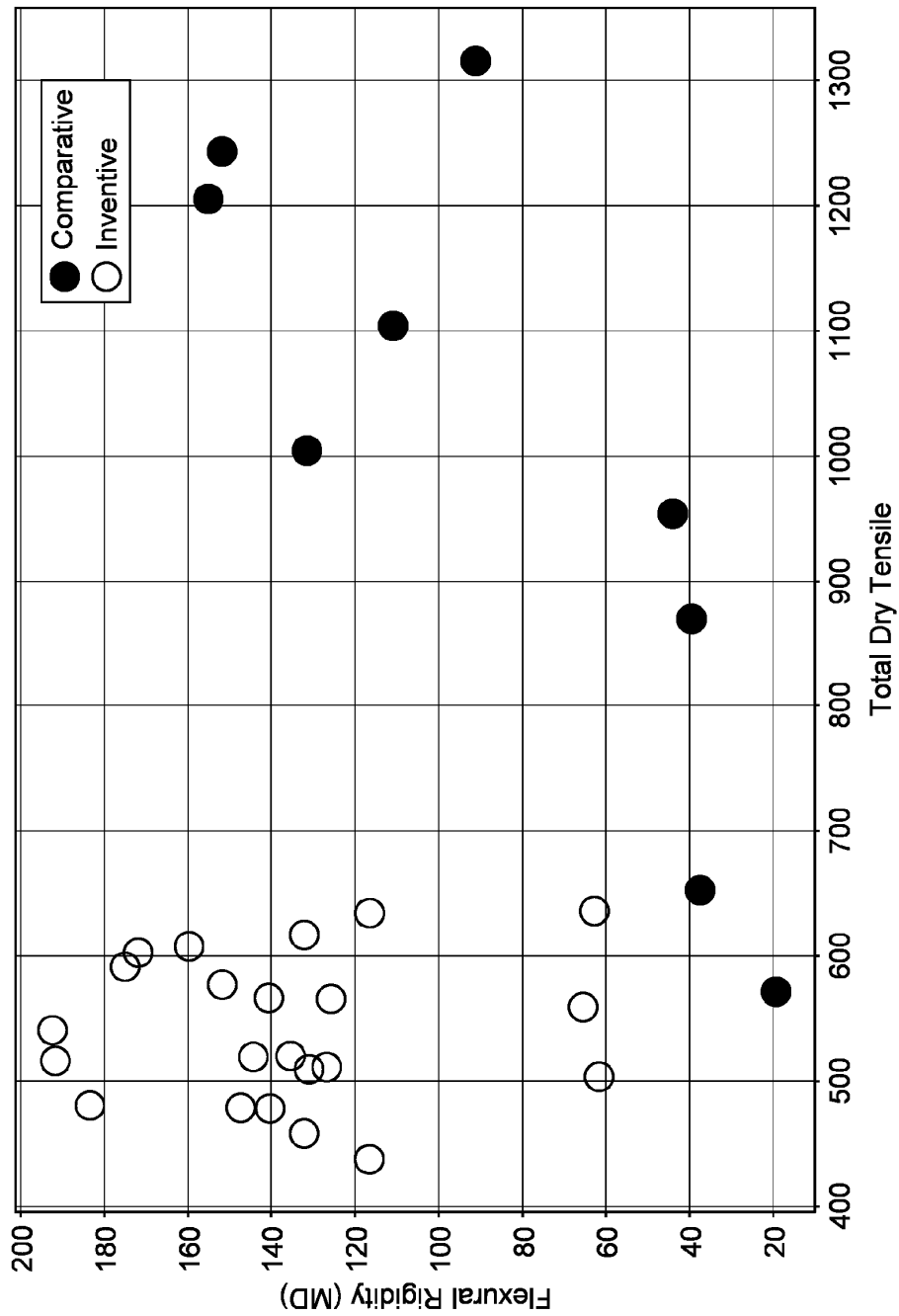


FIG. 1M

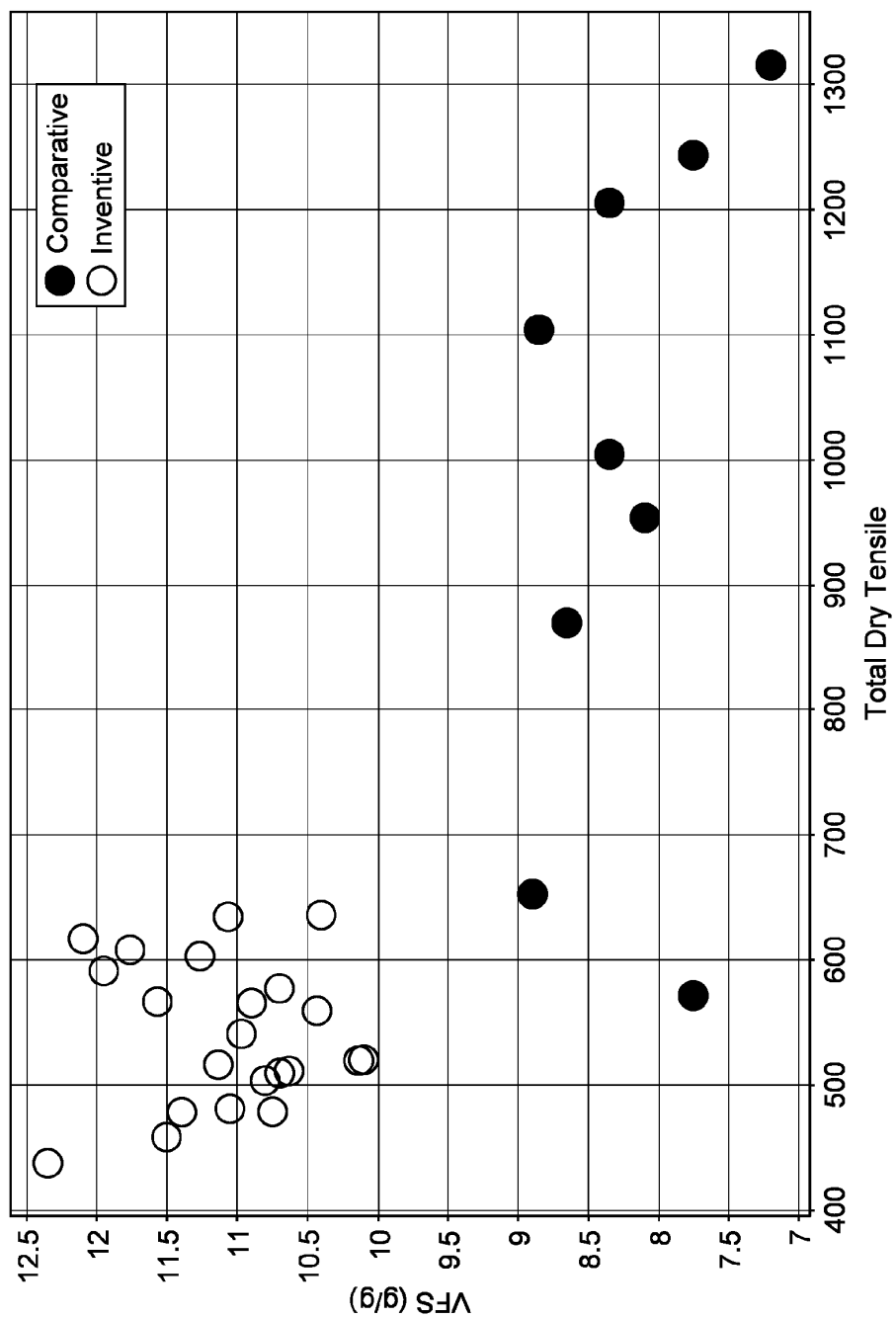


FIG. 1N

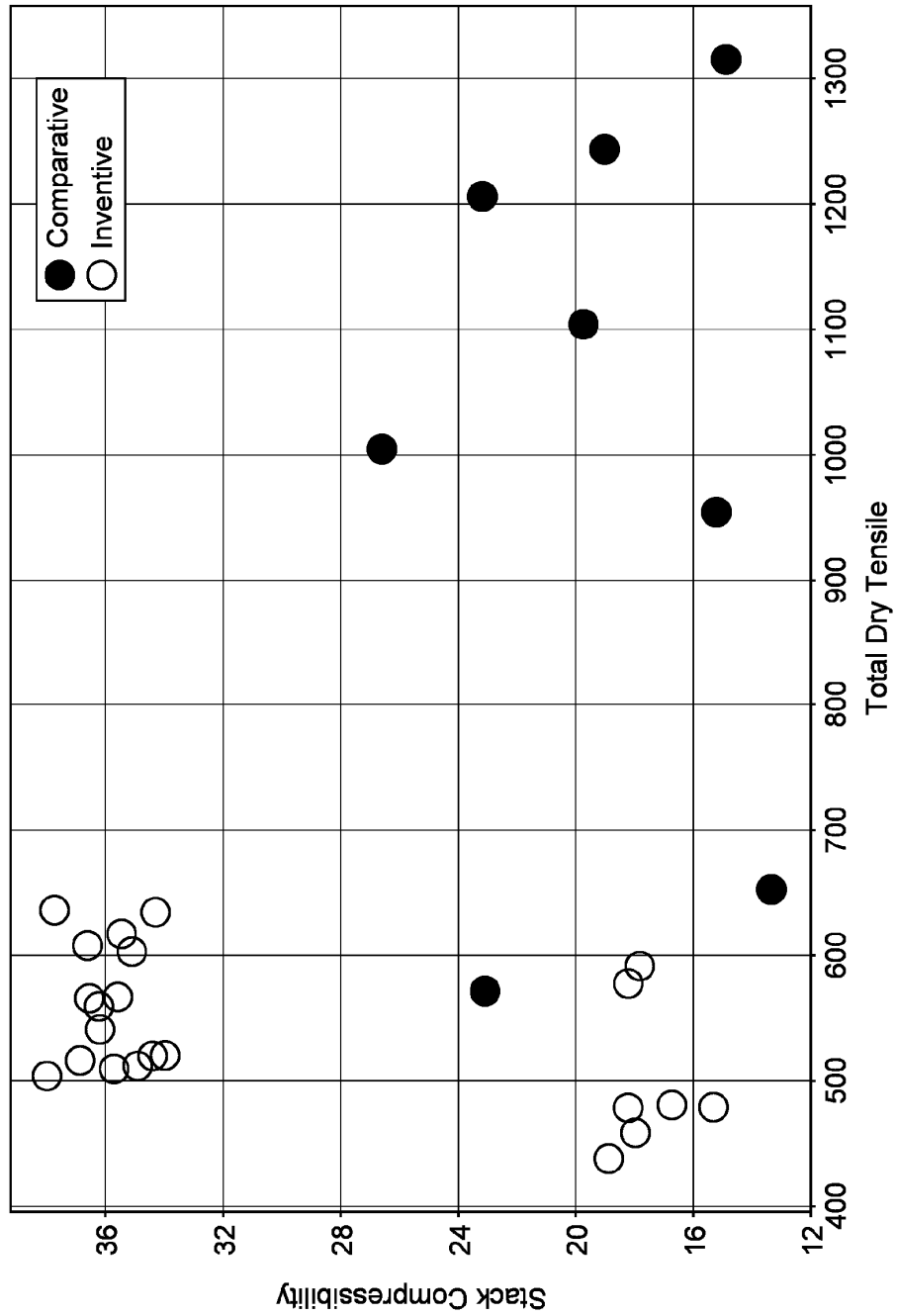


FIG. 10

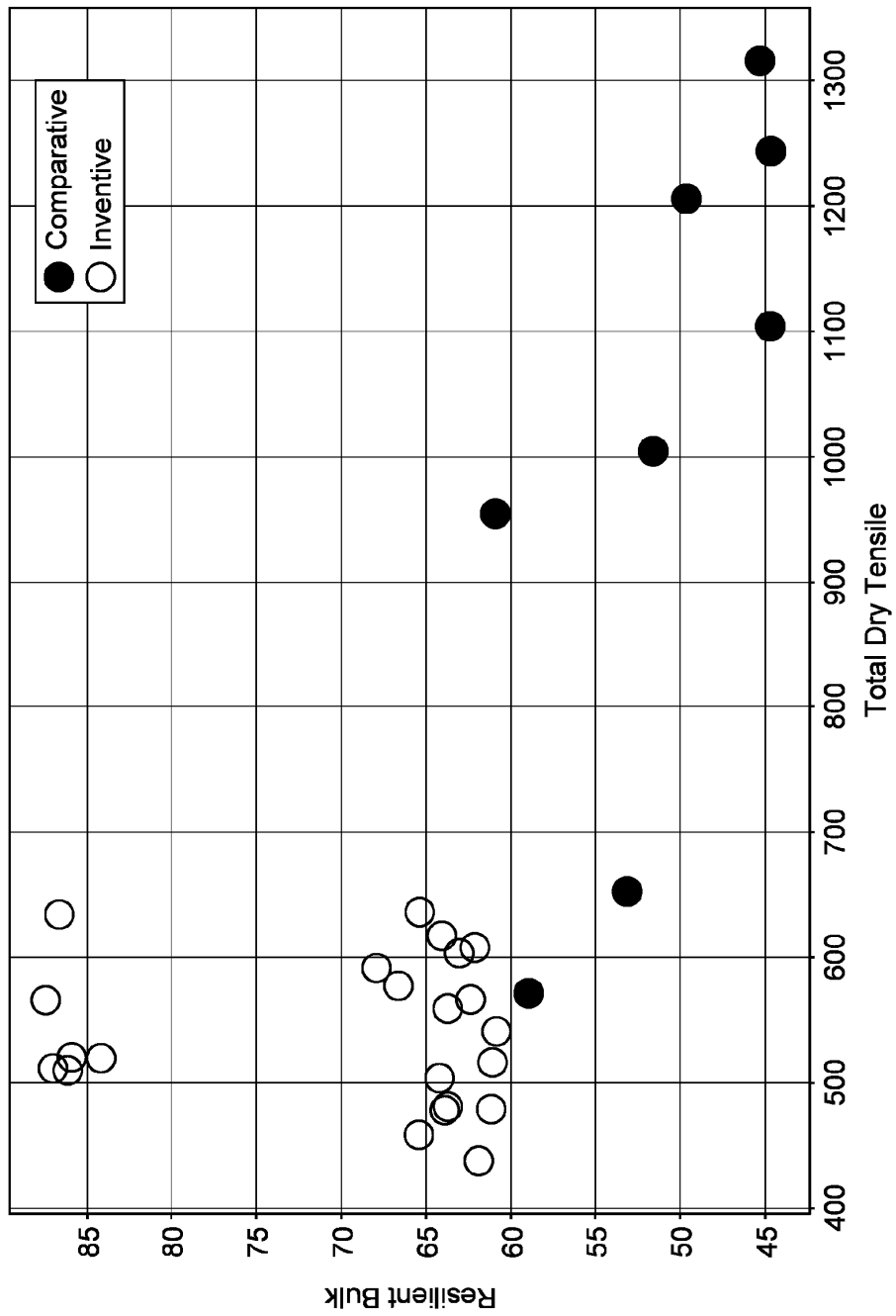


FIG. 1P

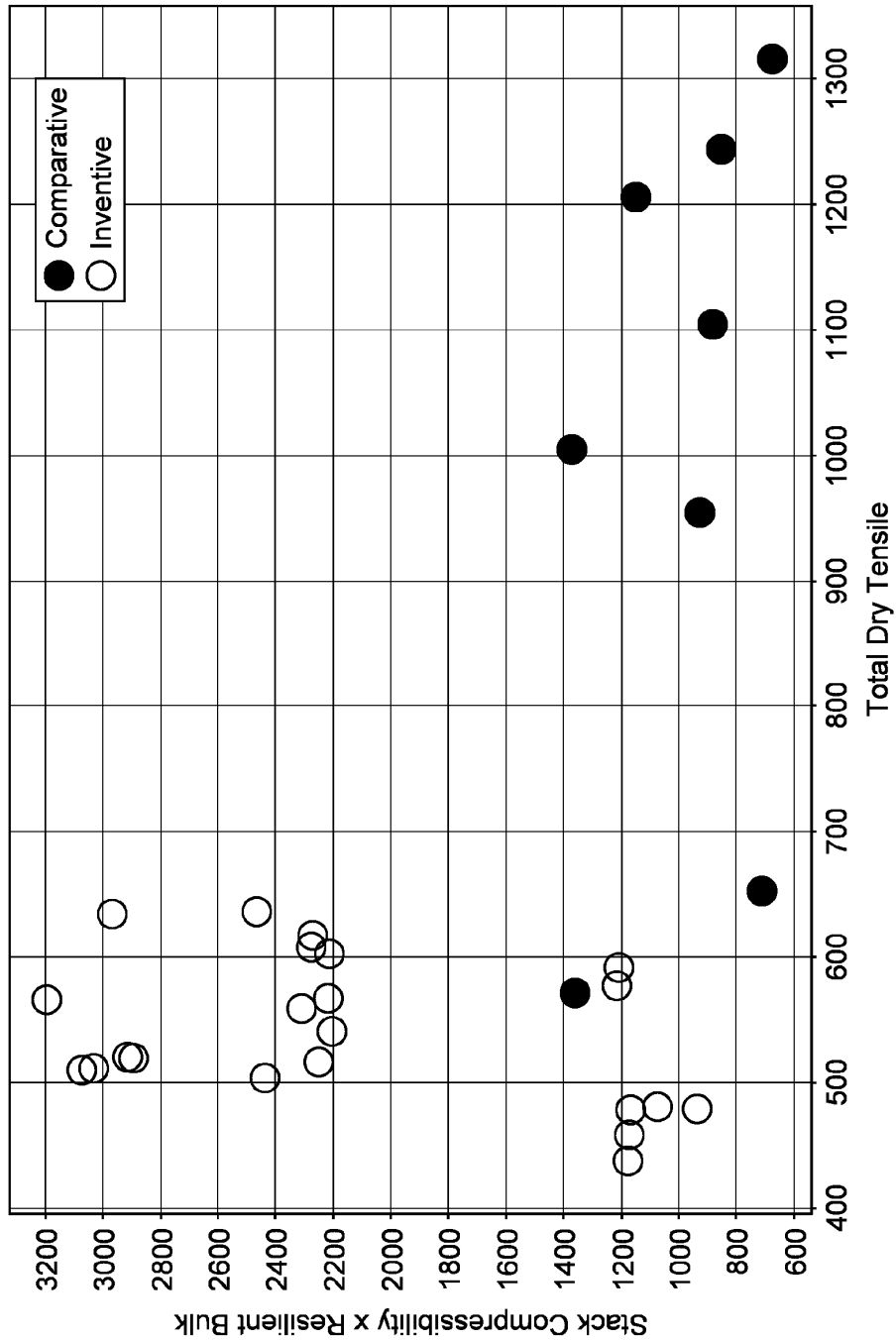


FIG. 1Q

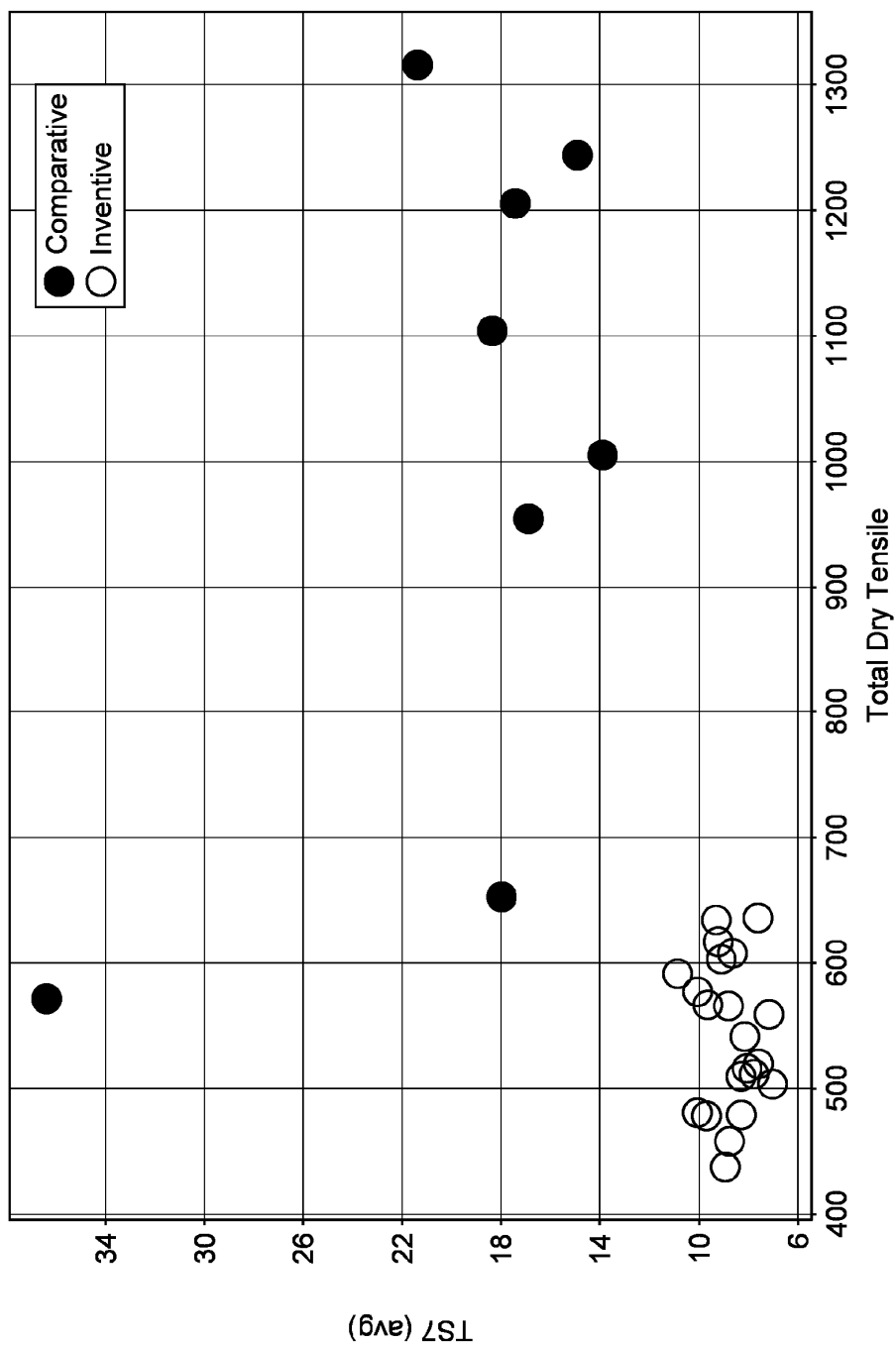


FIG. 1R

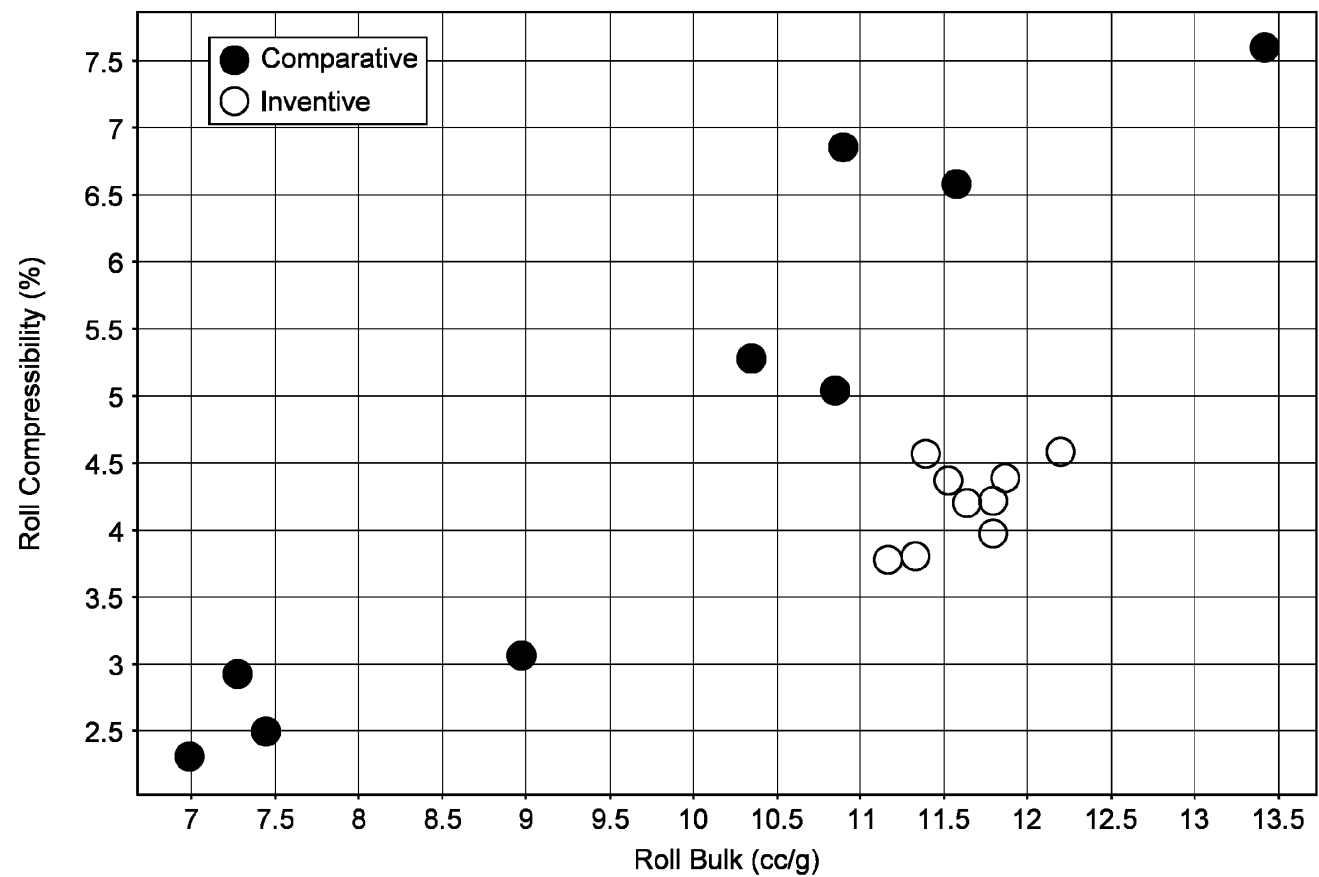


FIG. 2A

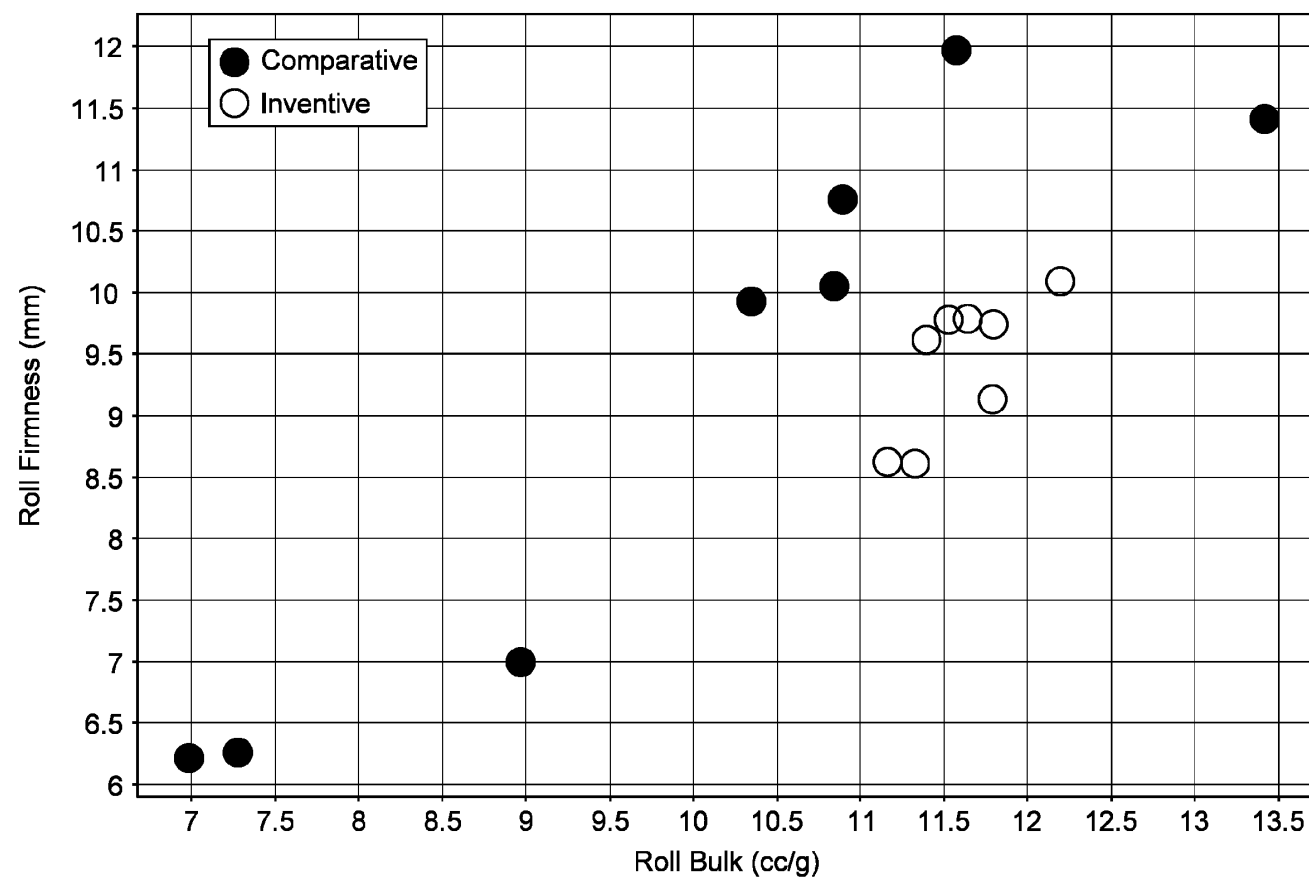


FIG. 2B

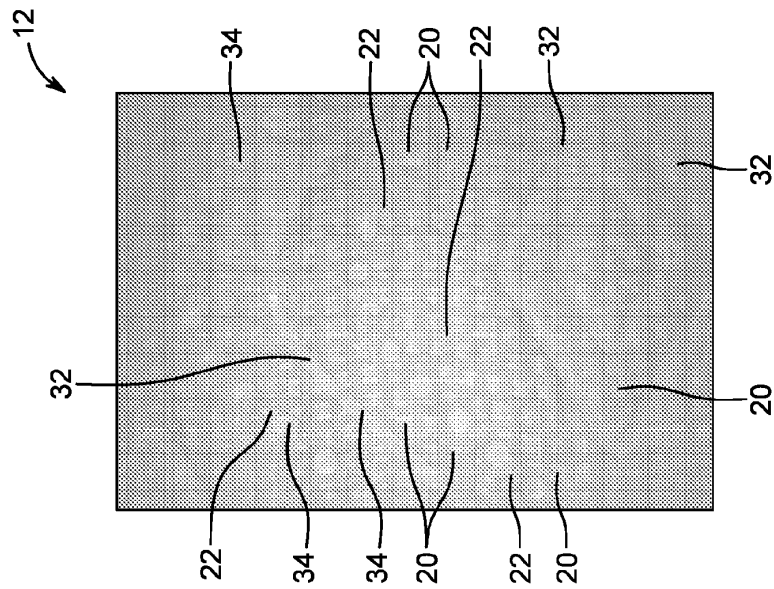


FIG. 3A

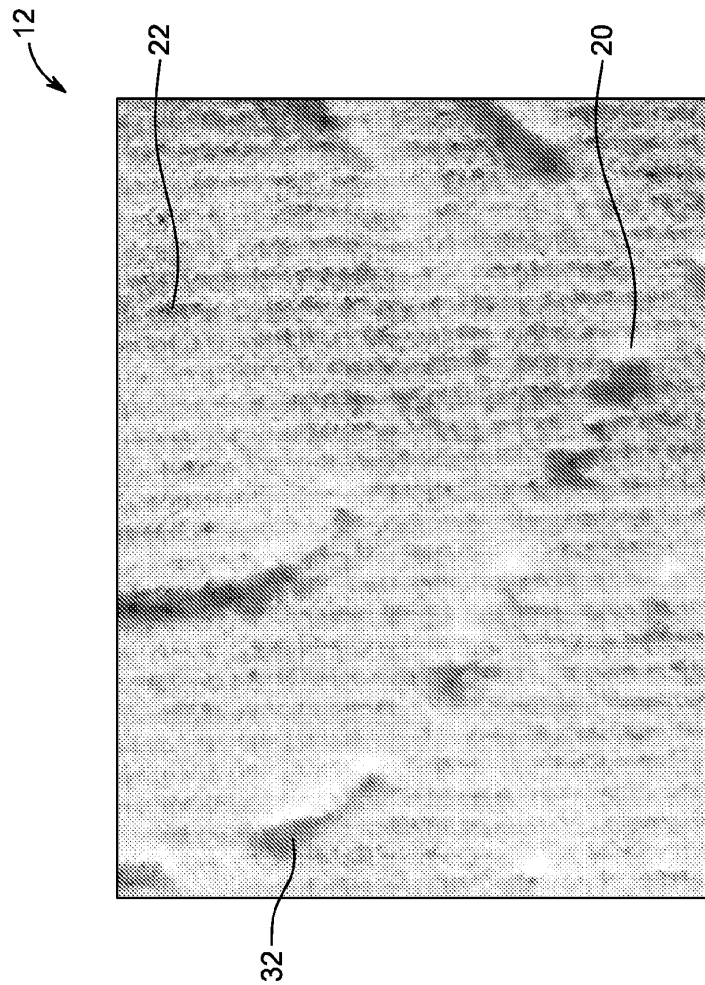


FIG. 3B

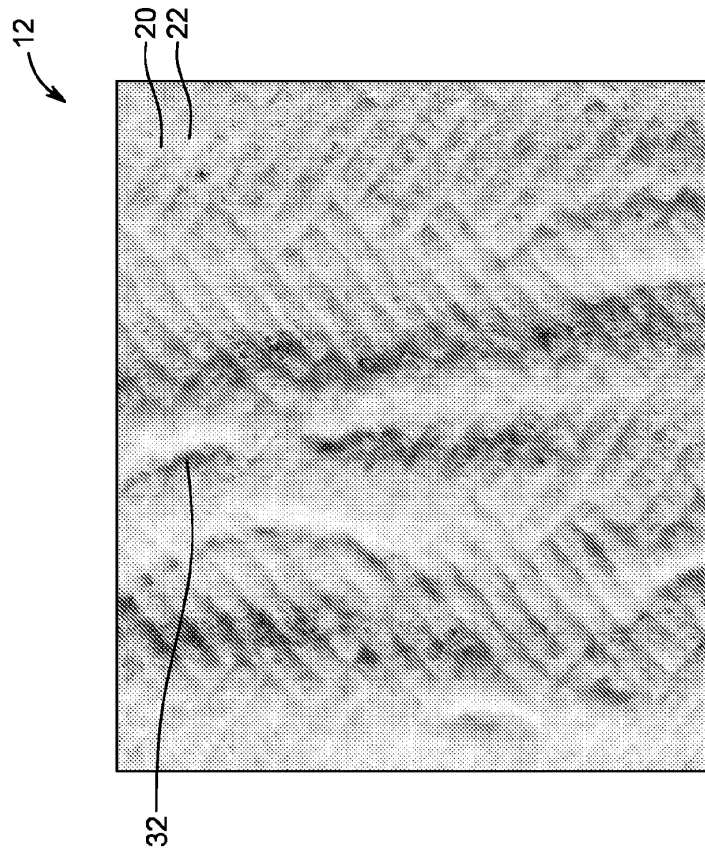


FIG. 3C

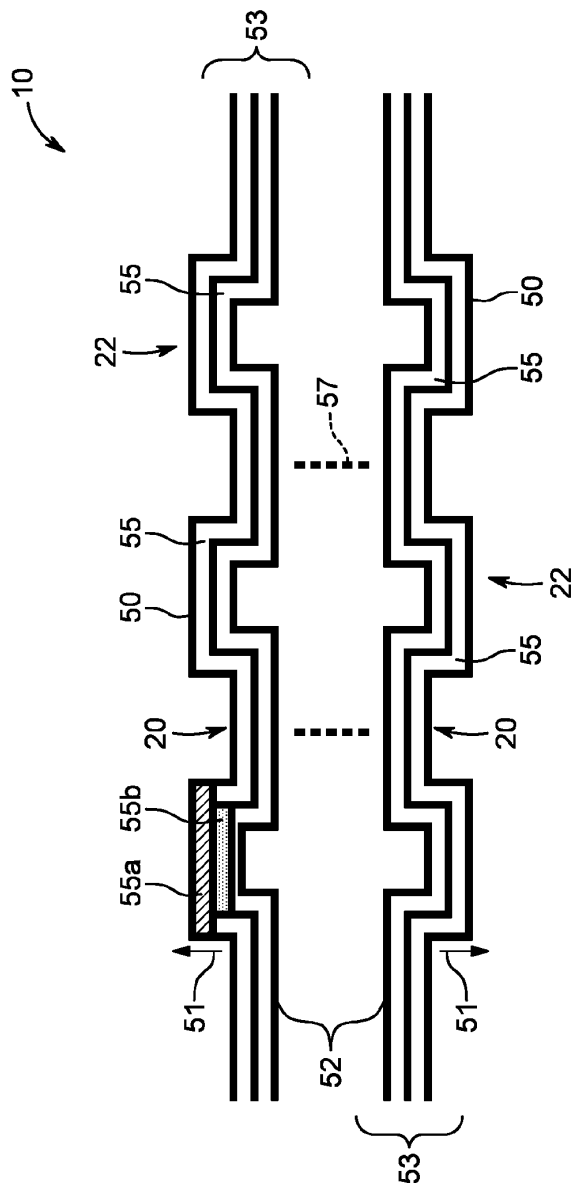


FIG. 4A

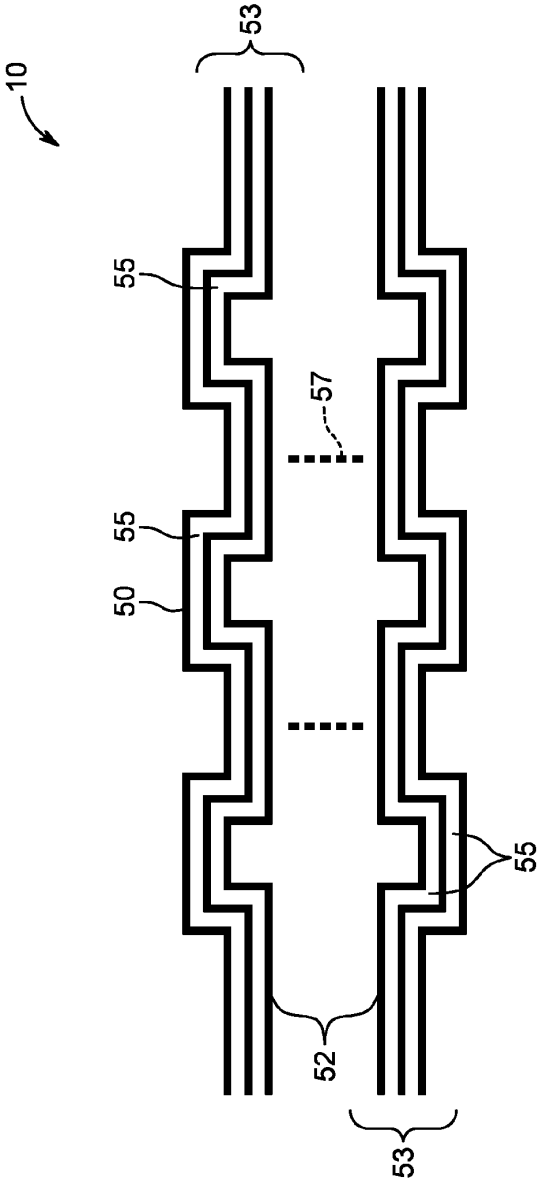


FIG. 4B

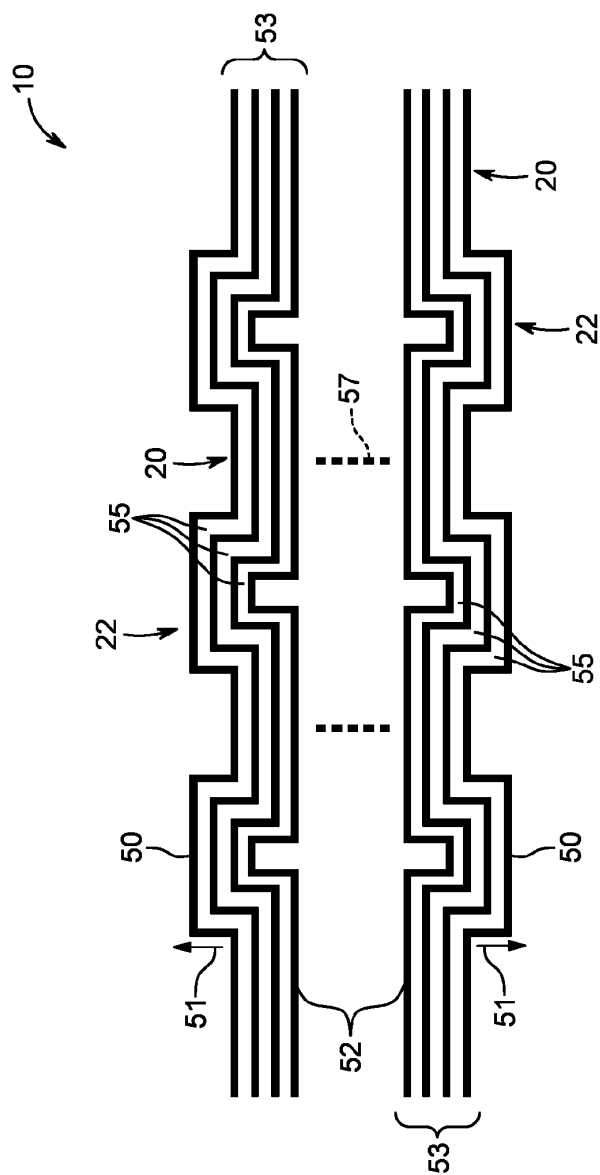


FIG. 4C

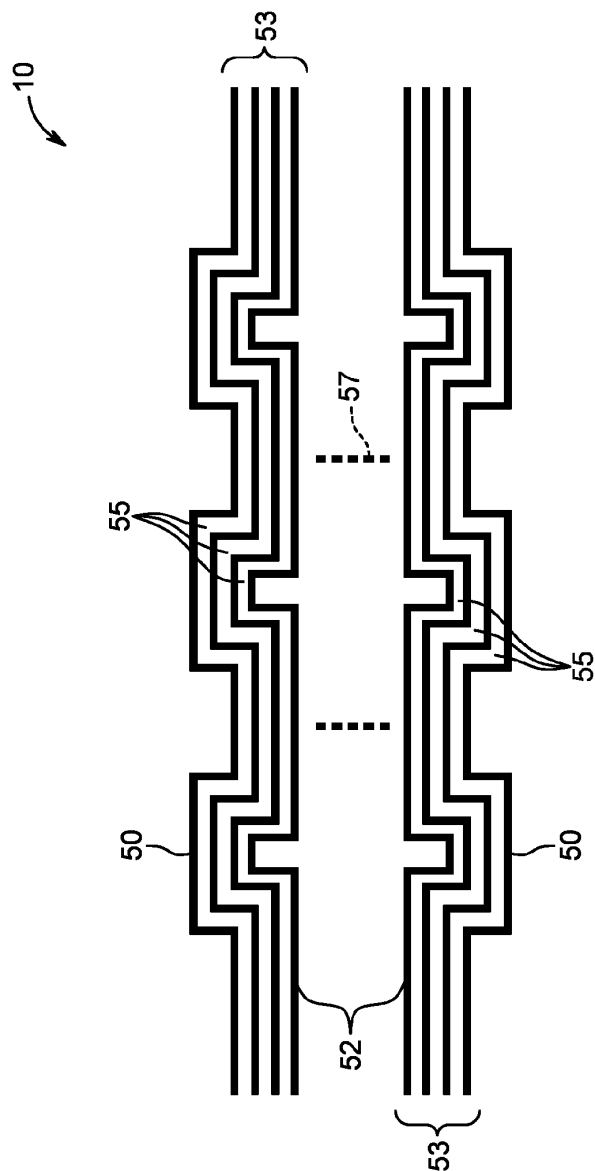


FIG. 4D

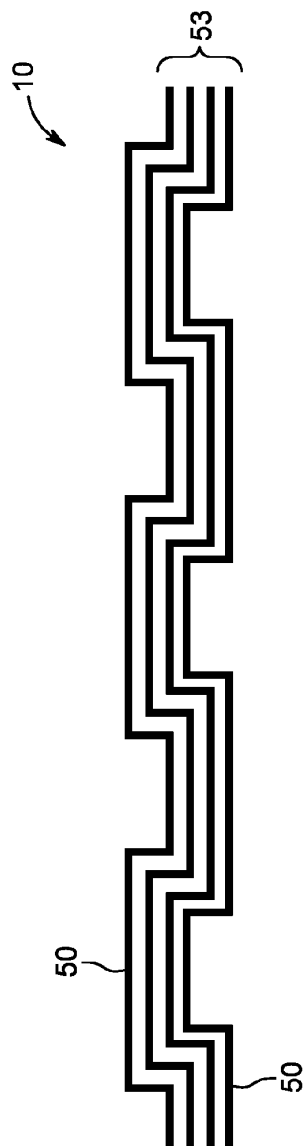


FIG. 4E

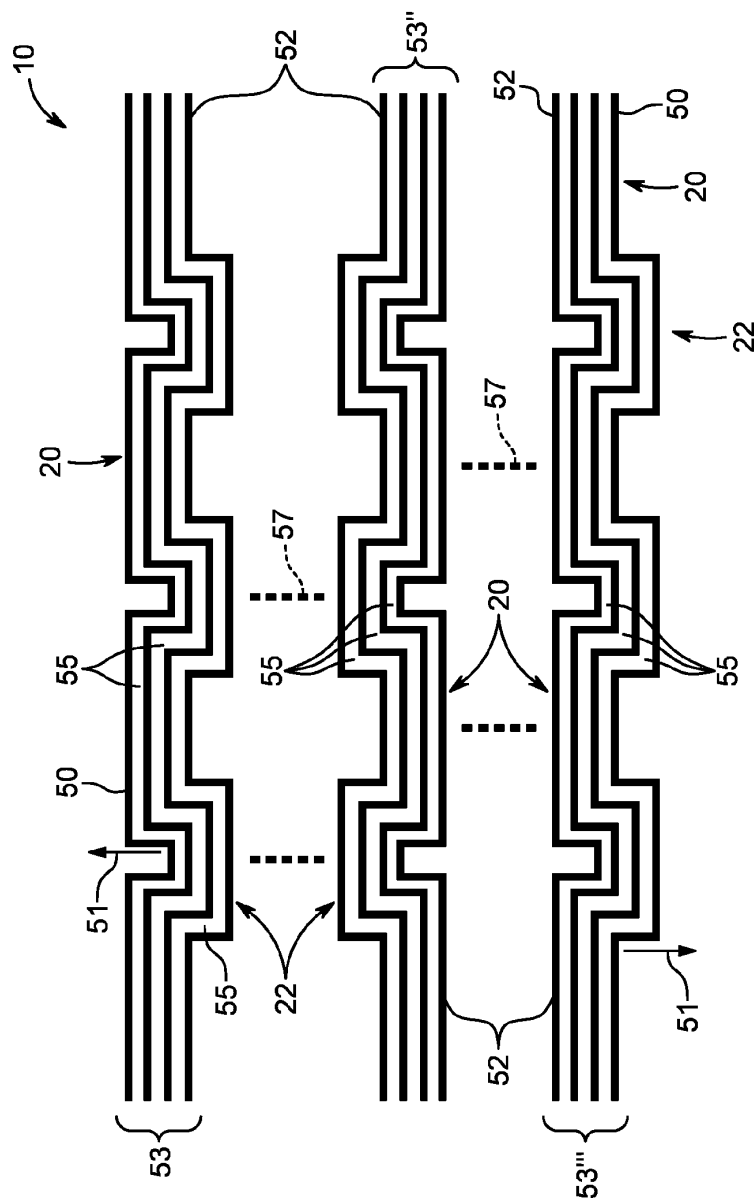


FIG. 4F

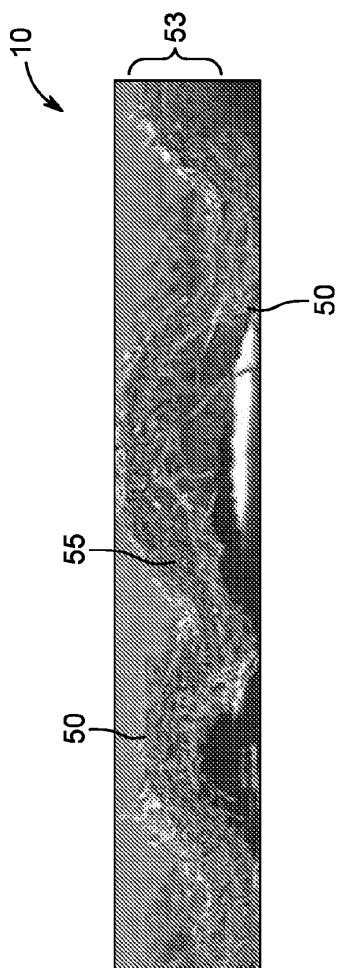


FIG. 4G

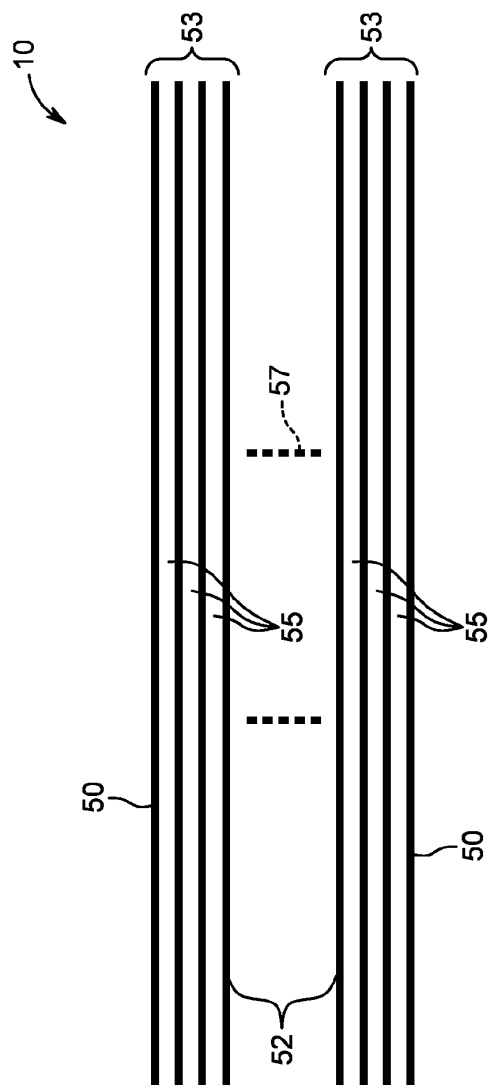


FIG. 4H

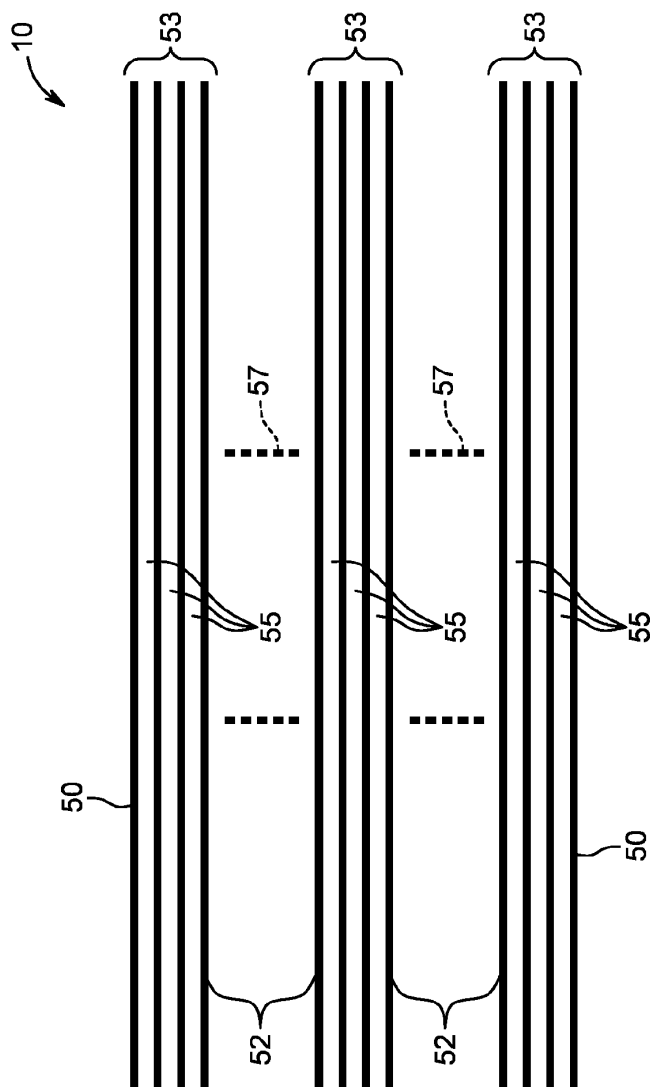


FIG. 4I

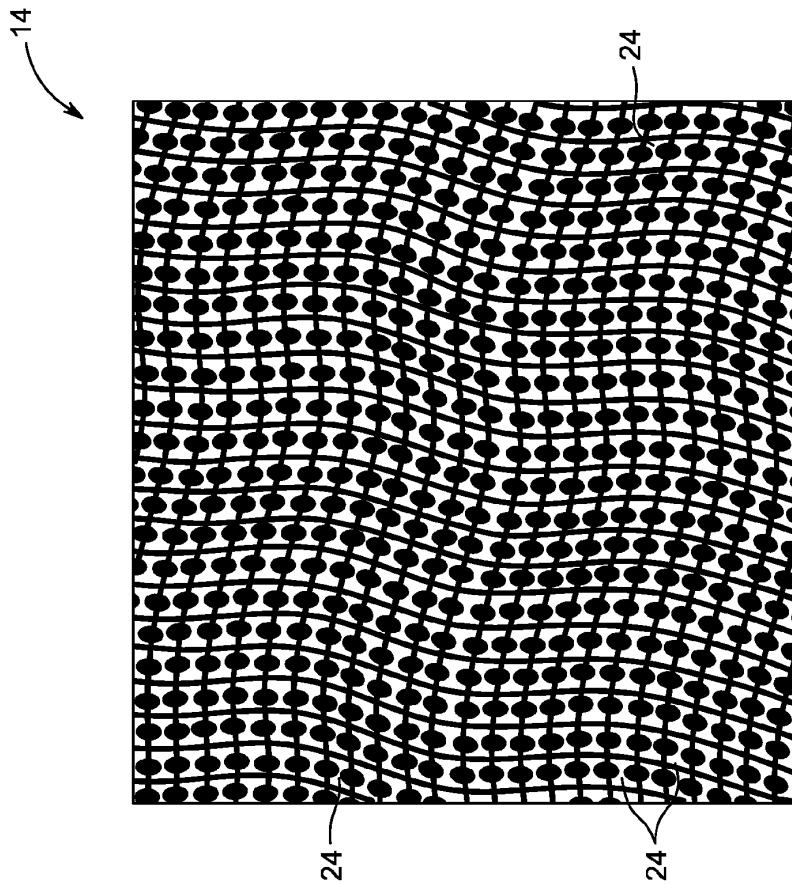


FIG. 5

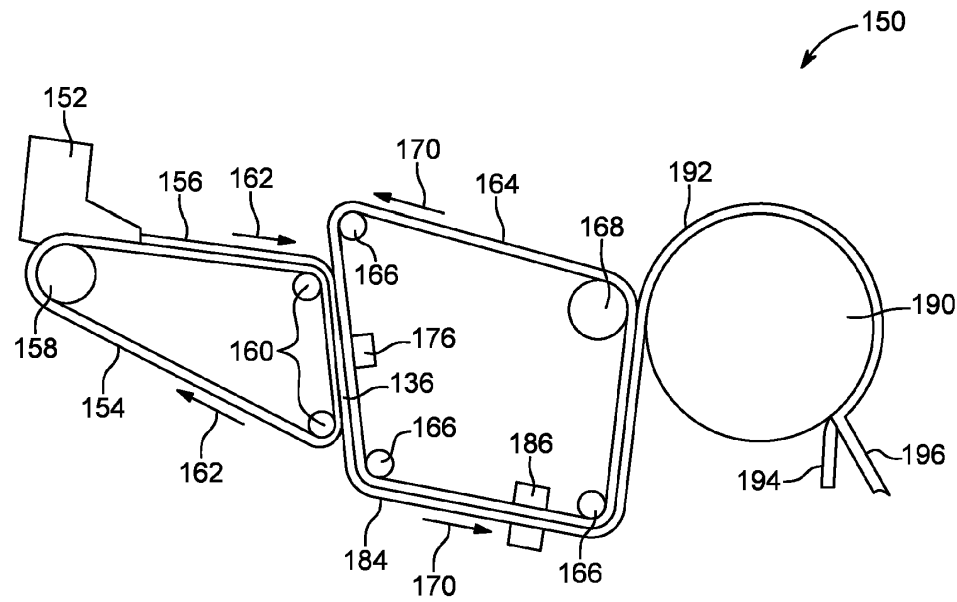


FIG. 6A

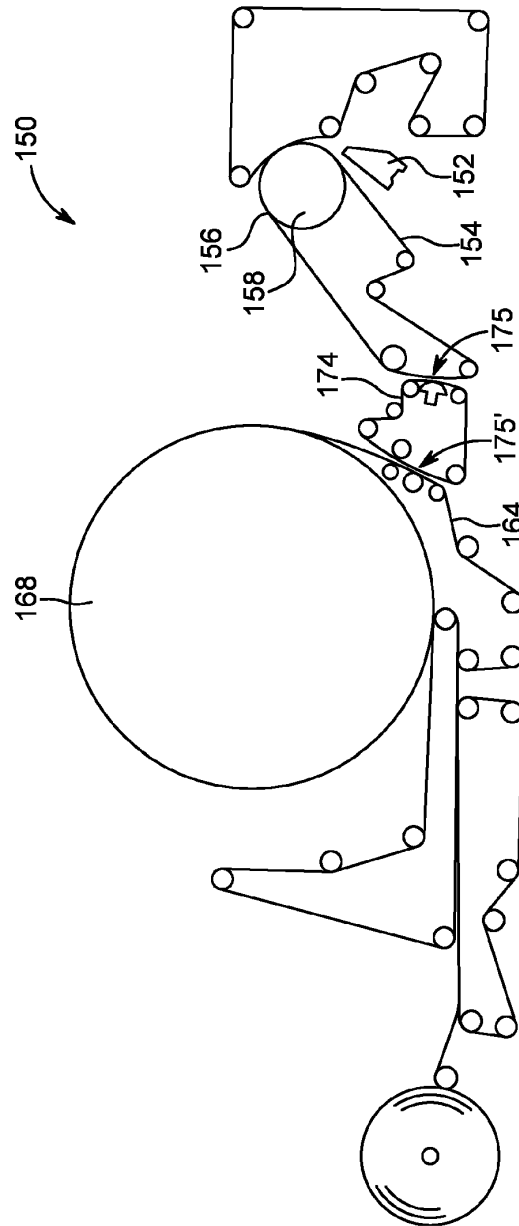


FIG. 6B

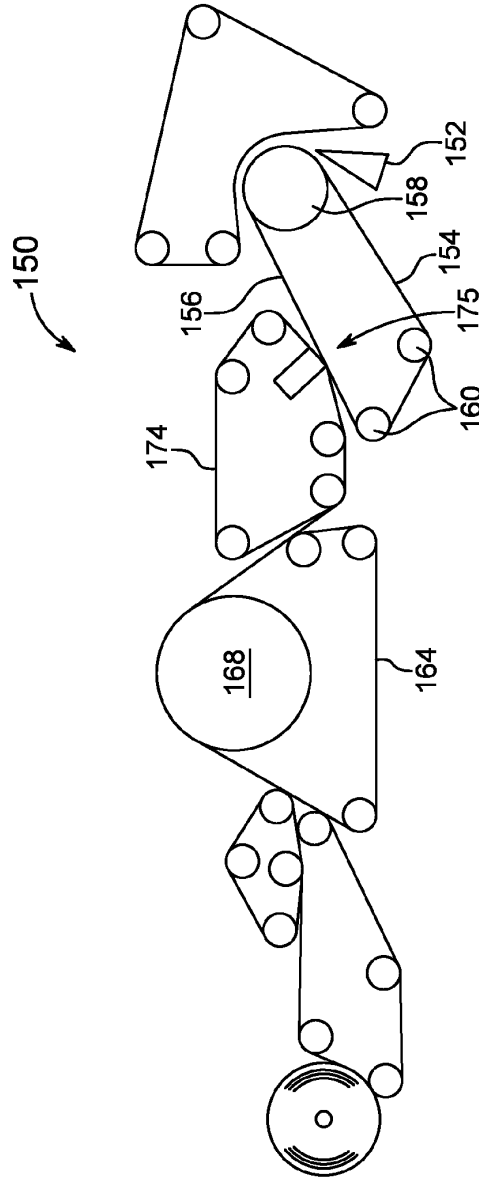


FIG. 6C

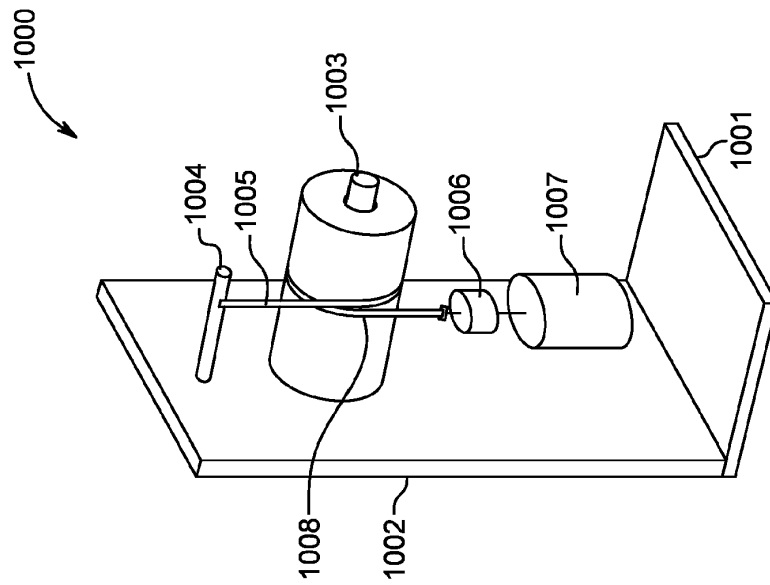


FIG. 7

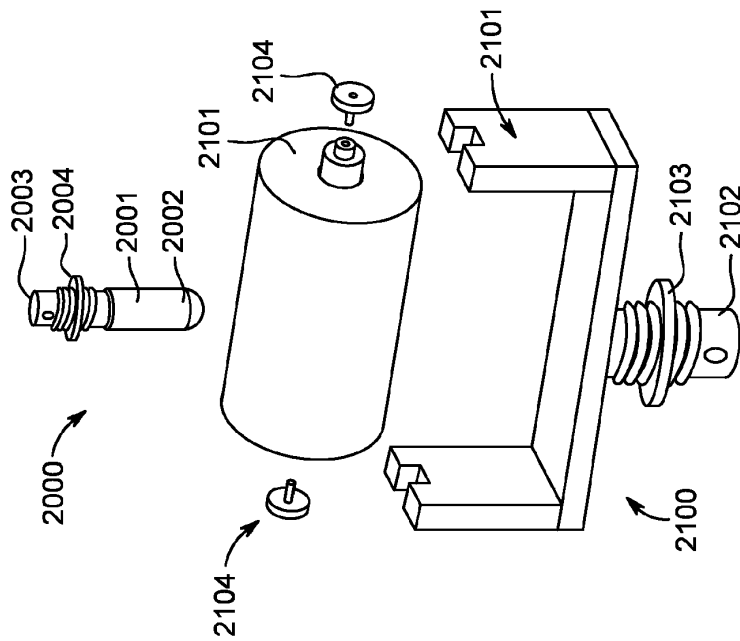


FIG. 8

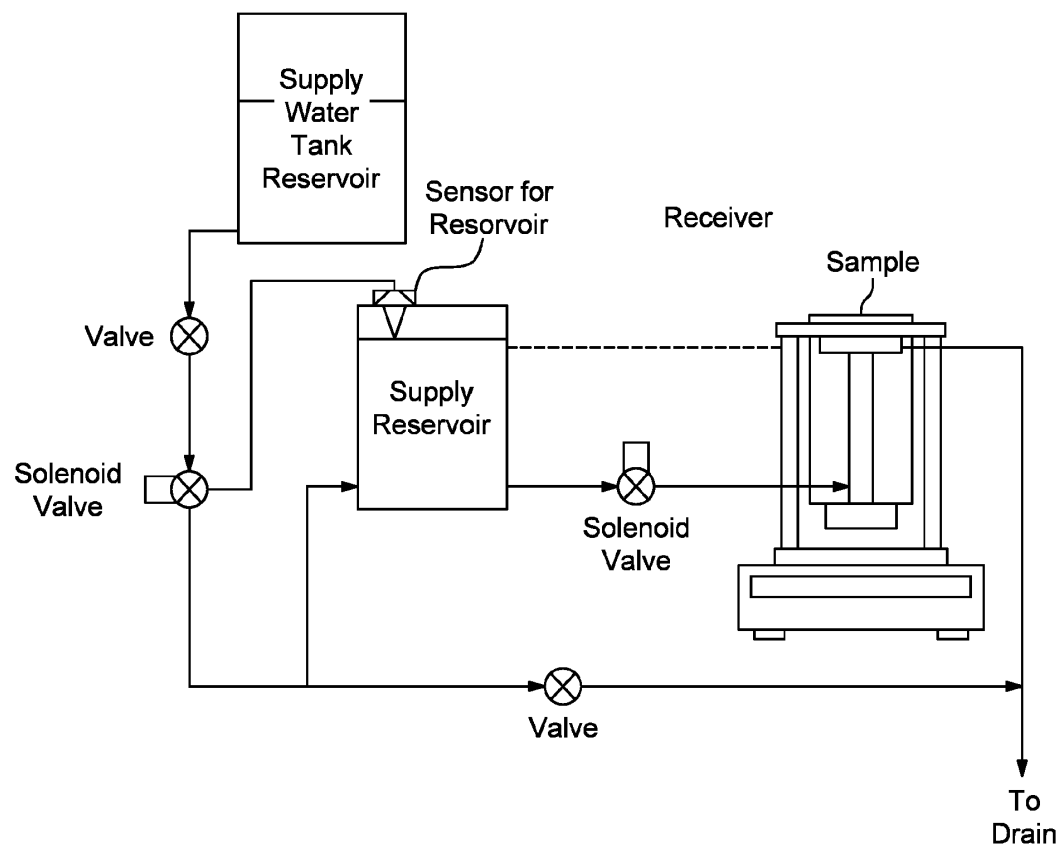


FIG. 9

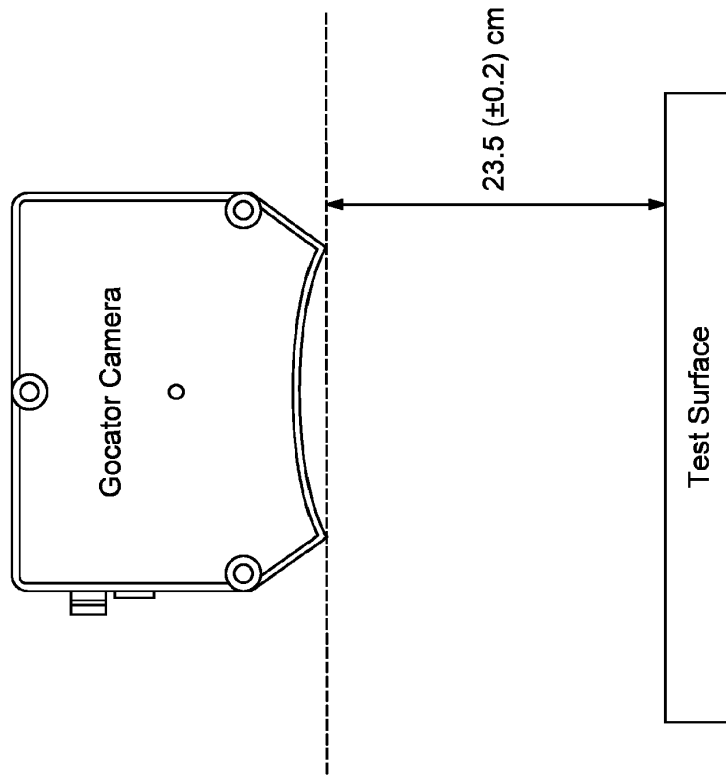


FIG. 10

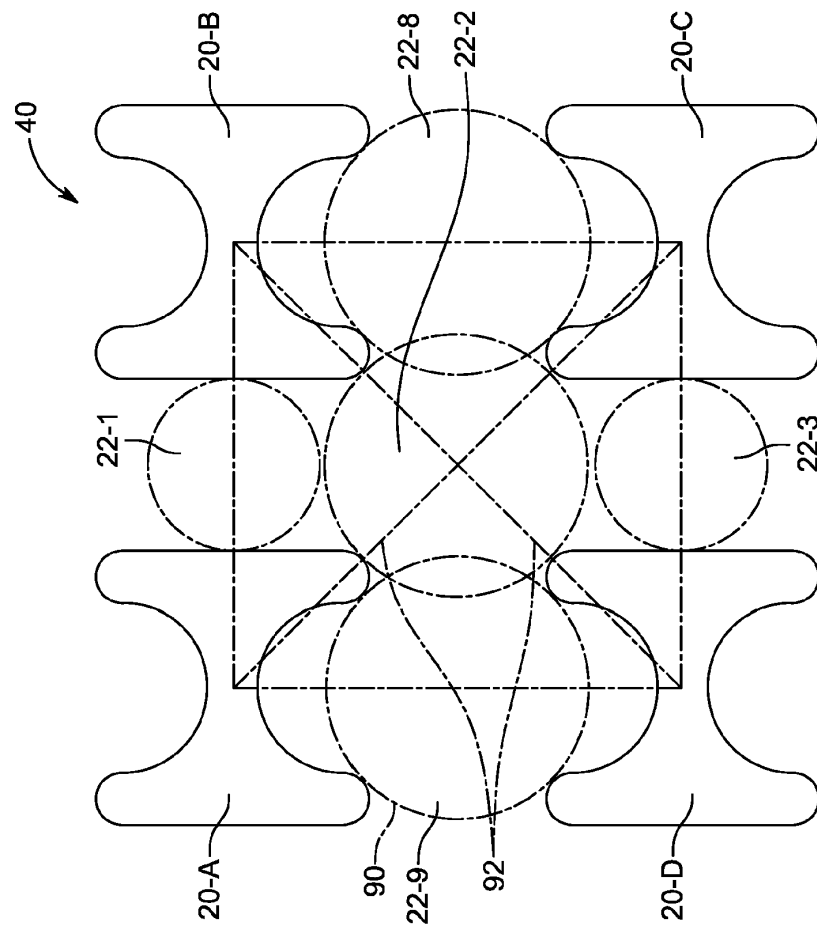


FIG. 11

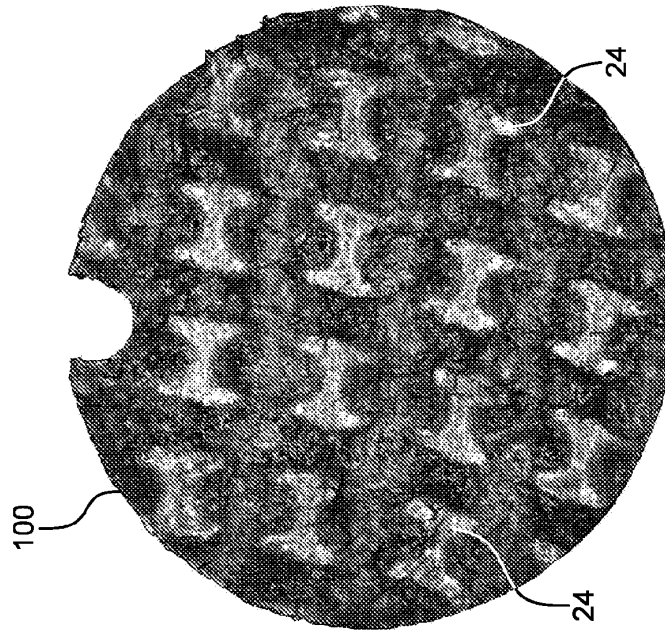


FIG. 12

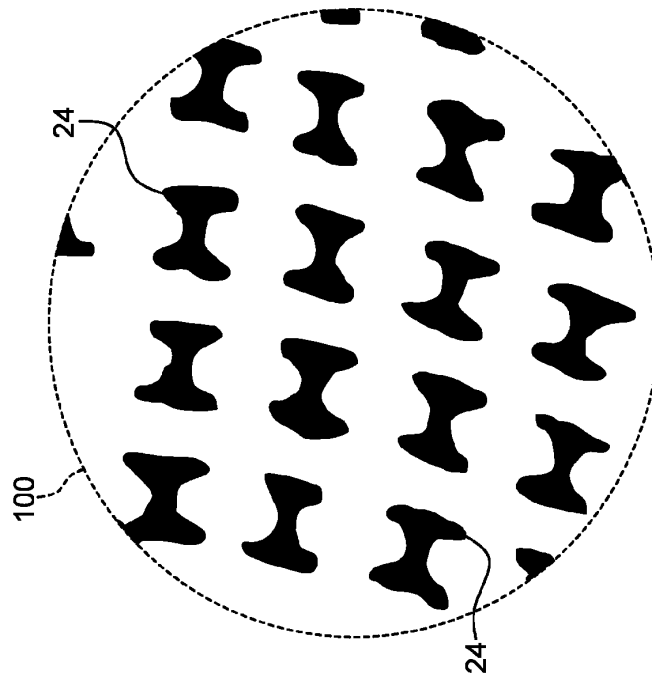


FIG. 13

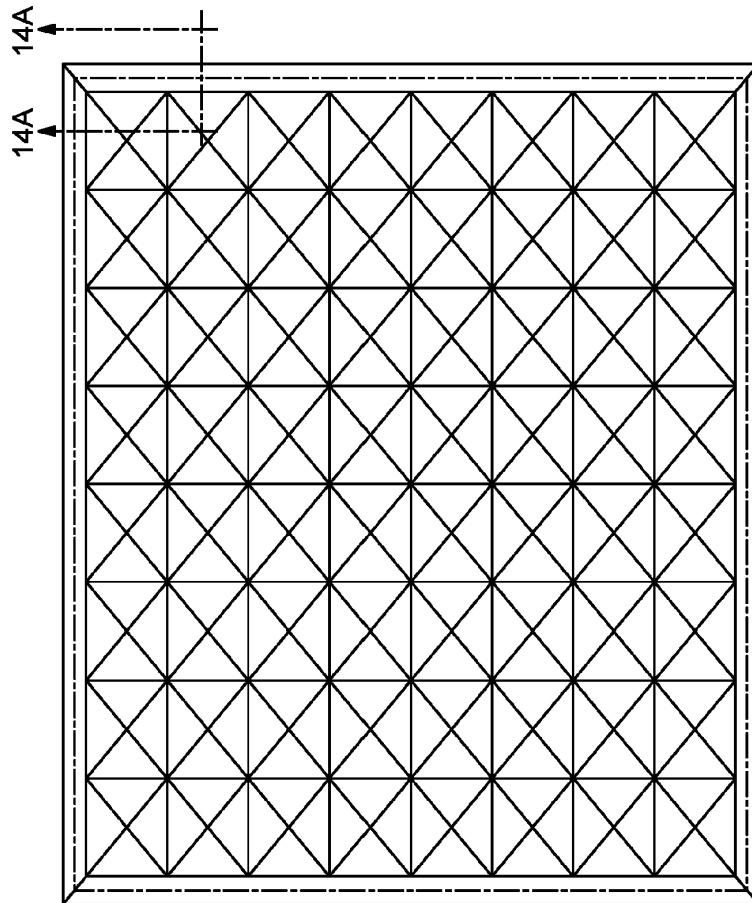


FIG. 14

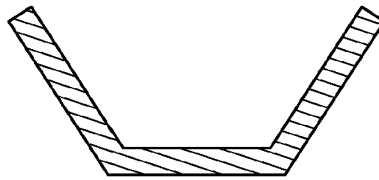


FIG. 14A

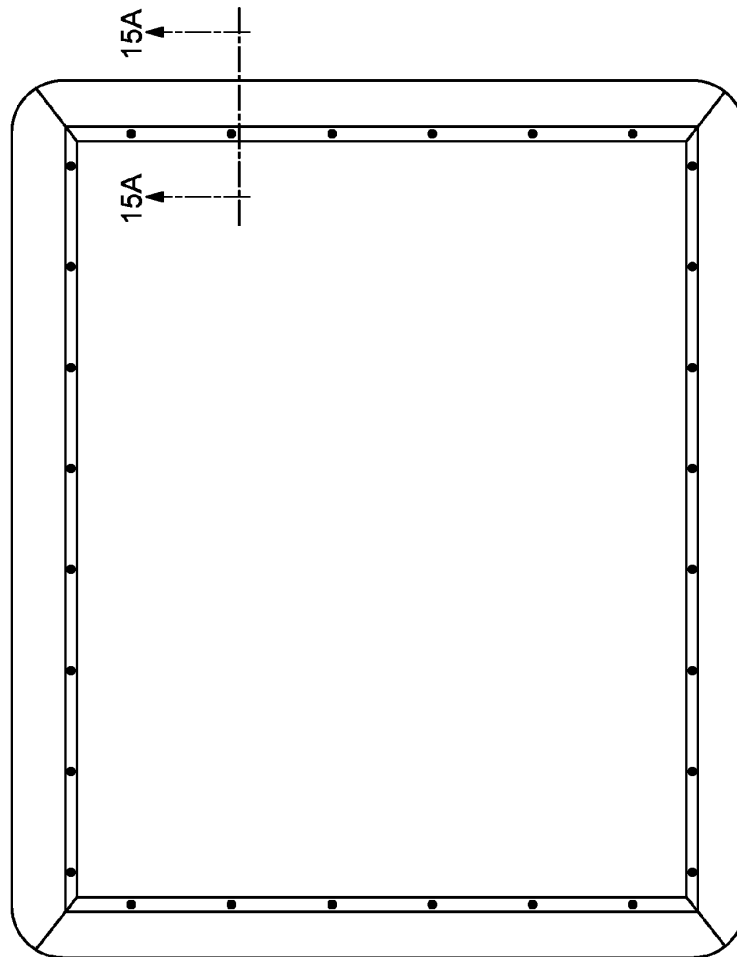


FIG. 15

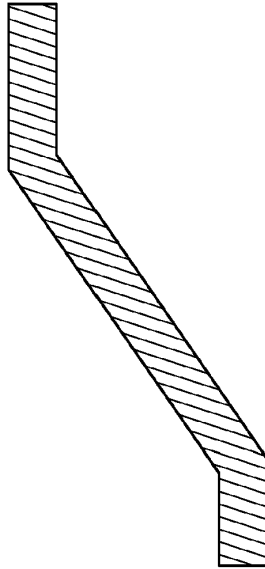


FIG. 15A

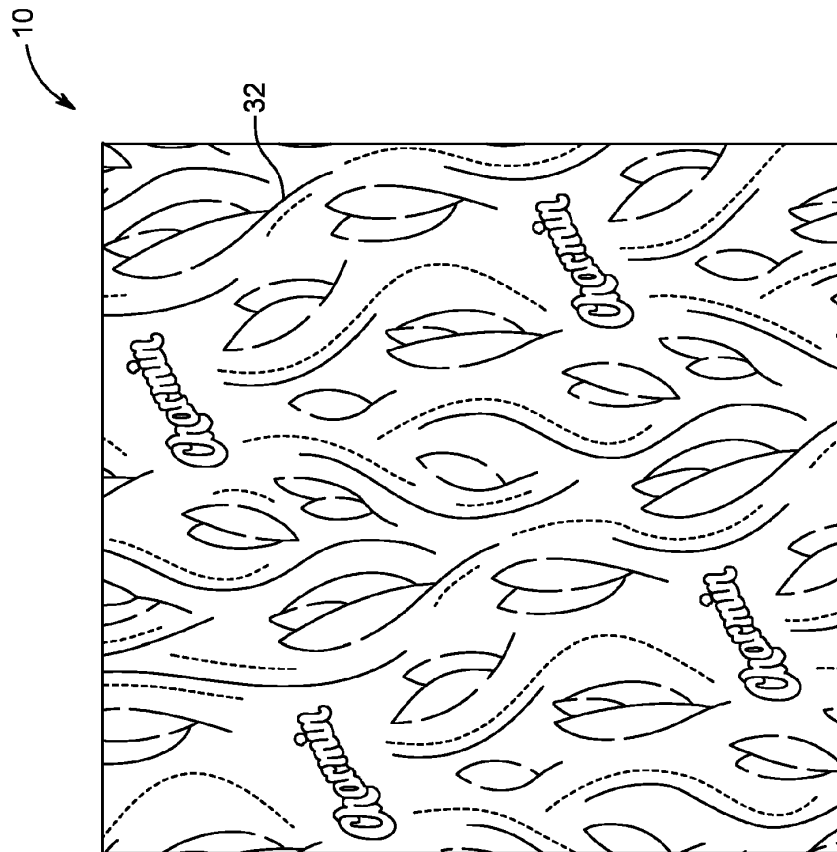


FIG. 16A

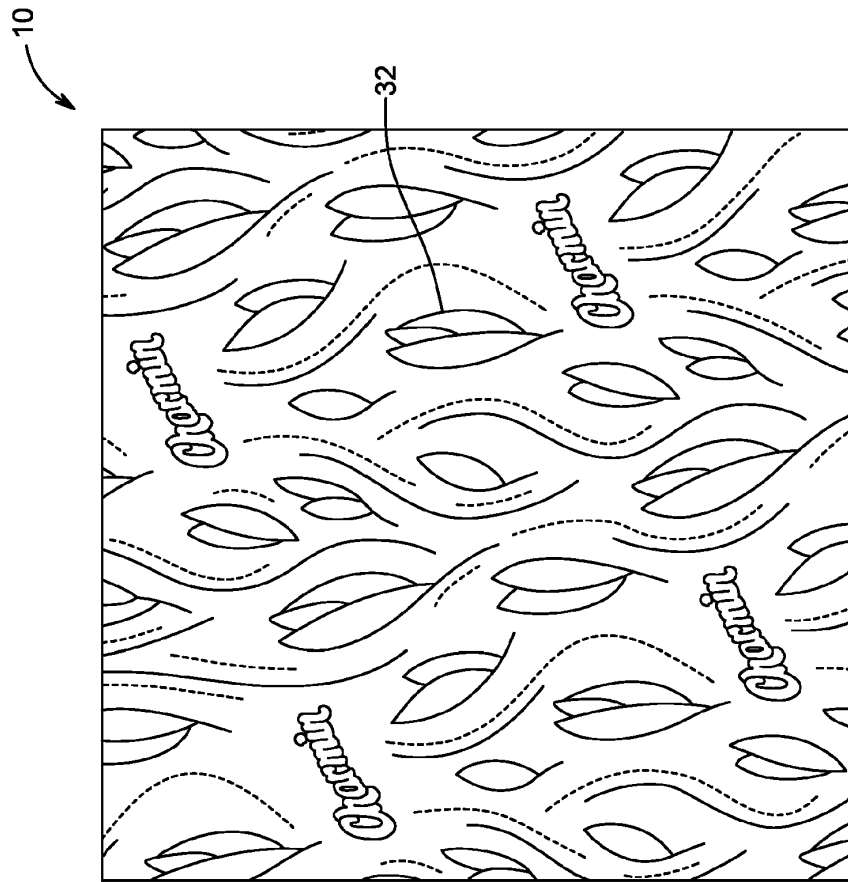


FIG. 16B

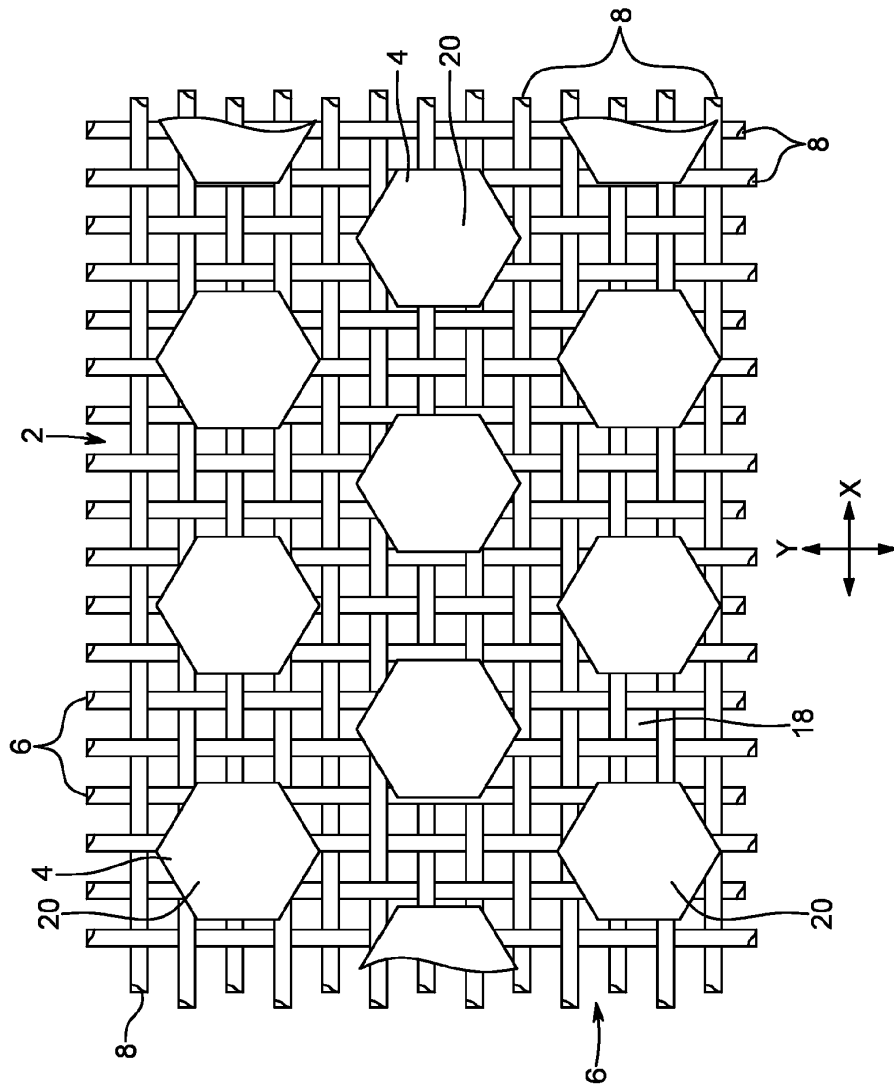


FIG. 17

Sample ID	% Short Fiber Inclusion	# of Piles	Type	Furnish Mix	Basis Weight	Near-zero load caliper	Comp-ressive Modulus Slope	Comp-ressive Modulus	Near-zero load caliper (200g)	Comp-ressive Modulus Slope (200g)	Comp-ressive Modulus (200g)	Dry Caliper
Z01	65	2	Traditional	Euc/SW	30.18	35.57	6.83	5.23	35.90	-6.60	5.47	22.23
1	100	2	Inventive	Euc	29.78	38.17	-7.63	5.07	36.03	-6.83	5.37	24.67
2	100	2	Inventive	Euc	30.54	36.93	-7.17	5.23	36.10	-6.97	5.27	24.00
3	100	2	Inventive	Euc	31.14	36.27	-6.93	5.27	34.87	-6.47	5.43	24.63
4	100	2	Inventive	Euc	31.44	36.83	-7.13	5.20	37.03	-7.30	5.13	23.50
5	100	2	Inventive	Euc	30.23	36.57	-7.33	5.07	36.70	-7.20	5.10	24.07
6	100	2	Inventive	Euc	30.68	36.60	-6.77	5.47	35.10	-6.30	5.70	23.83
7	100	2	Inventive	Euc	29.34	32.61	-6.52	5.01				23.45
8	95	2	Inventive	Euc/Abaca	31.35	32.98	-7.13	4.66				23.15
9	95	2	Inventive	Euc/Abaca	29.74	37.14	-6.35	5.90				24.45
10	95	2	Inventive	Euc/Abaca	29.72	34.52	-6.89	5.06				24.65
11	95	2	Inventive	Euc/Abaca	30.85	29.62	-5.13	5.83				23.75
12	100	2	Inventive	Euc	29.78	36.37	-7.04	5.20				25.80
13	95	2	Inventive	Euc/Abaca	30.64	38.02	-6.63	5.80				24.60
Z02	65	2	Traditional	Euc/SW	29.15	38.66	-7.96	4.90	40.29	-8.94	4.53	23.77
14	75	2	Inventive	Euc/SW	30.61	39.30	-7.86	5.03	38.93	-8.09	4.87	24.90
15	85	2	Inventive	Euc/SW	29.72	39.72	-8.24	4.84	37.52	-7.62	4.95	24.27
16	95	2	Inventive	Euc/SW	30.43	39.89	-7.96	5.07	40.21	-8.54	4.78	24.27
17	100	2	Inventive	Euc	30.09	41.45	-8.69	4.81	37.97	-7.49	5.18	24.07

FIG. 18-1

Sample ID	% Short Fiber Inclusion	# of Piles	Type	Furnish Mix	Basis Weight	Near-zero load caliper	Compressive Modulus Slope	Compressive Modulus	Near-zero load caliper (200g)	Compressive Modulus Slope (200g)	Compressive Modulus (200g)	Dry Caliper
A	100	3	Comparative	Euc	26.24	28.45	-5.42	5.29	29.03	-4.78	6.13	18.35
B	100	2	Comparative	Euc	17.38	18.33	-2.94	6.37	20.40	-2.90	7.38	12.85
C	100	2	Comparative	Euc	18.79	16.58	-2.51	6.62	19.48	-2.60	7.50	12.35
D	100	1	Comparative	Euc	11.14	22.62	-4.55	4.98	22.73	-4.05	5.63	14.10
E	71	2	Comparative	Euc/SW	24.06	19.73	-3.43	5.79	19.98	-3.48	5.78	13.40
F	77	3	Comparative	Euc/SW	32.28	25.78	-5.11	5.19	24.96	-4.50	5.72	16.80
G	83	3	Comparative	Euc/SW	31.31	23.54	-4.14	5.74	22.57	-4.00	5.68	16.40
H	91	3	Comparative	Euc/SW	26.29	24.79	-5.34	4.69	26.78	-5.48	4.94	17.75
C1	100	2	Comparative	Euc	18.34	16.77	-2.15	7.95	16.38	-2.11	8.07	12.20
Z03	65	2	Traditional	Euc/SW	32.05	38.24	-7.67	5.03	37.47	-7.39	5.11	22.83
18	95	2	Inventive	Euc/SW	32.02	35.71	-6.61	5.44	37.67	-7.38	5.19	22.67
19	100	2	Inventive	Euc	31.76	36.77	-6.94	5.39	37.34	-7.17	5.26	23.20
20	95	2	Inventive	Euc/SW	32.91	37.06	-6.12	6.10	38.15	-6.48	5.91	24.77
21	100	2	Inventive	Euc	34.43	38.29	-6.78	5.66	38.56	-6.85	5.65	24.87
22	100	2	Inventive	Euc/Bagasse	30.90	39.56	-7.25	5.48	40.63	-7.55	5.44	24.93

FIG. 18-1 (Cont'd)

Sample ID	Peak Load CD Tensile	CD Elongation (dry)	CD Tea	CD Modulus	Peak Load MD Tensile	MD Elongation (dry)	MD TEA	MD Modulus	Total Dry Tensile	Geometric Mean (GM) Dry Modulus	CD Tear	MD Tear	GM Tear
Z01	189.10	11.33	12.58	862.67	404.37	27.63	59.58	787.27	593.47	823.99	16.57	19.67	18.05
1	182.03	7.17	6.77	1110.77	328.10	24.97	44.22	711.03	510.13	888.57	10.77	9.43	10.08
2	186.53	7.37	7.28	1115.83	324.77	22.57	41.88	873.87	511.30	987.42	10.27	10.60	10.43
3	191.03	6.33	6.23	1298.27	329.73	24.23	45.13	819.10	520.77	1030.26	10.37	11.43	10.89
4	188.03	6.33	6.03	1290.43	332.03	24.60	45.23	773.27	520.07	998.62	9.87	11.03	10.43
5	196.80	6.87	6.93	1235.70	369.00	23.13	44.78	791.87	565.80	988.80	11.50	9.80	10.62
6	237.57	6.33	8.07	1617.93	397.27	26.53	59.73	990.77	634.83	1266.07	13.23	13.33	13.28
7	180.85	12.75	12.50	636.80	257.05	22.35	30.40	525.65	437.90	578.01	5.47	7.03	6.20
8	187.35	8.00	8.10	1051.15	292.30	24.50	41.80	712.65	479.65	863.86	4.83	8.50	6.41
9	174.10	9.10	8.75	898.05	304.15	25.05	38.40	516.90	478.25	680.33	4.50	8.60	6.22
10	230.75	8.50	10.55	1232.65	347.15	24.10	41.00	552.00	577.90	824.85	7.37	10.57	8.82
11	201.30	11.55	12.65	786.65	279.55	21.15	32.75	649.05	480.85	714.52	7.43	12.00	9.44
12	256.40	16.10	21.95	724.55	335.15	26.35	46.25	579.15	591.55	647.60	7.20	11.13	8.95
13	175.75	12.20	11.90	675.90	283.00	21.30	30.25	557.80	458.75	613.97	5.00	9.07	6.73
Z02	208.33	13.13	15.90	764.37	407.60	24.73	51.83	821.50	615.93	792.31	29.30	21.40	25.04
14	213.13	11.53	13.90	865.93	395.13	23.27	48.73	876.87	608.27	871.07	26.00	20.13	22.88
15	197.23	12.20	13.23	703.10	420.07	24.13	55.07	1008.27	617.30	841.82	23.77	17.50	20.39
16	234.43	9.23	11.27	1046.20	369.27	23.80	48.17	903.20	603.70	971.92	19.10	14.80	16.81
17	206.77	9.57	10.13	875.77	360.03	22.83	45.90	957.33	566.80	915.62	14.57	13.03	13.78

FIG. 18-2

Sample ID	Peak Load CD Tensile	CD Elongation (Dry)	CD Tea	CD Modulus	Peak Load MD Tensile	MD Elongation (dry)	MD TEA	MD Modulus	Total Dry Tensile	Geometric Mean (GM) Dry Modulus	CD Tear	MD Tear	GM Tear
A	302.60	8.40	14.60	1711.90	702.35	23.30	84.55	1185.65	1004.95	1424.68	10.70	11.70	11.19
B	287.00	7.50	11.95	1841.75	667.45	25.65	86.55	1086.05	954.45	1413.09	9.90	10.20	10.05
C	194.75	6.30	6.85	1464.90	458.65	22.35	54.20	1024.15	653.40	1224.37	5.70	7.20	6.41
D	196.00	4.05	4.25	2134.15	376.30	17.20	30.20	805.90	572.30	1310.92	6.70	8.70	7.63
E	438.30	9.60	26.45	3148.15	877.65	36.50	158.45	1448.55	1315.95	2135.47	18.30	20.00	19.13
F	327.90	9.70	20.55	2028.75	776.45	34.40	147.40	1283.65	1104.35	1613.75	18.80	21.20	19.96
G	314.95	9.55	19.70	1960.50	929.00	28.00	141.00	1732.80	1243.95	1843.14	13.80	16.80	15.23
H	326.05	9.85	20.65	2018.50	880.10	25.25	122.05	1842.40	1206.15	1928.44	16.10	11.90	13.84
C1	231.75	7.40	9.90	1569.40	637.75	21.80	75.00	1349.50	869.50	1455.30	7.45	8.20	7.82
Z03	193.57	12.43	13.00	675.93	367.77	22.80	44.20	781.87	561.33	726.85	19.30	17.67	18.47
18	205.47	8.27	8.73	1030.20	335.57	20.83	39.93	962.63	541.03	995.70	14.43	12.53	13.45
19	189.77	8.77	8.50	880.97	326.67	21.00	38.97	913.67	516.43	897.17	12.73	11.13	11.91
20	219.80	10.50	12.03	885.10	339.50	20.20	41.13	1147.27	559.30	1007.47	12.47	10.63	11.51
21	197.70	10.07	10.33	848.53	306.00	18.17	33.07	1052.83	503.70	945.18	11.63	9.13	10.31
22	248.47	11.63	14.27	838.27	387.73	21.00	46.60	1231.37	636.20	1015.96	11.90	11.53	11.72

FIG. 18-2 (Cont'd)

Sample ID	Flexural Rigidity MD mg-cm	Flexural Rigidity CD mg-cm	Flexural Rigidity Avg mg-cm	Lint-outside	Perf Tens Peak Load	Perf Tens Peak Elong	Perf Tens Peak TEA	Perf WTTF	HFS g/sht	HFS g/g	VFS g/sht	VFS g/g	Wet Burst Strength	WB Peak BEA
Z01	125.87	120.29	123.08	10.14	175.50	12.9	13.4	22.9	10.33	19.67	6.07	11.50	49.27	22.6
1	130.87	133.03	131.95	8.92	115.80	7.4	5.2	8.8	9.87	19.37	5.47	10.70	31.80	11.8
2	126.82	139.56	133.19	7.54	99.47	4.9	3.0	5.0	9.60	18.73	5.47	10.63	24.67	8.6
3	135.44	150.40	142.92	9.32	100.33	5.4	3.3	5.5	9.53	18.17	5.27	10.10	20.90	7.6
4	144.34	150.56	147.45	9.82	103.13	5.6	3.5	5.9	9.17	17.23	5.37	10.13	20.83	6.8
5	125.73	140.14	132.93	8.12	106.93	7.7	4.7	8.3	9.53	18.73	5.53	10.90	33.90	12.5
6	116.53	201.28	158.90	8.22	104.03	5.6	3.7	6.2	9.67	18.30	5.83	11.07	24.93	9.4
7	116.63	160.63	138.63	7.63	98.85	8.3	4.2	8.4	10.95	22.05	6.15	12.35	21.90	0.3
8	147.30	173.16	160.23	9.16	110.20	7.4	4.5	8.3	10.05	19.10	5.65	10.75	30.05	0.5
9	140.47	232.49	186.48	5.53	102.25	10.0	5.8	10.3	10.30	20.50	5.70	11.40	29.65	0.5
10	151.75	311.76	231.75	4.28	147.15	11.4	8.5	16.9	9.75	19.30	5.40	10.70	31.45	0.5
11	183.37	249.27	216.32	4.91	127.05	8.4	5.5	10.6	9.45	18.30	5.75	11.05	22.40	0.4
12	175.02	261.41	218.22	6.33	129.35	9.9	6.8	12.8	10.65	20.40	6.25	11.95	22.15	0.3
13	132.28	194.26	163.27	7.95	100.95	6.8	3.6	7.0	9.70	19.25	5.80	11.50	27.40	0.4
Z02	124.80	185.98	155.39	8.30	210.23	16.2	17.7	34.5	11.40	23.63	6.00	12.40	44.50	0.7
14	159.72	171.68	165.70	8.72	197.37	13.1	13.5	26.4	11.20	22.03	5.97	11.77	38.93	0.6
15	132.17	251.79	191.98	6.34	183.87	10.8	10.6	20.2	11.33	22.83	6.00	12.10	21.20	0.3
16	171.79	215.38	193.58	7.15	154.50	9.5	7.4	14.8	10.33	20.63	5.67	11.27	8.87	0.1
17	140.60	199.69	170.14	6.23	151.13	8.8	6.4	13.5	10.50	21.30	5.73	11.57	25.87	0.4

FIG. 18-3

Sample ID	Flexural Rigidity MD mg-cm	Flexural Rigidity CD mg-cm	Flexural Rigidity Avg mg-cm	Lint-outside	Perf Tens Peak Load	Perf Tens Peak Elong	Perf Tens Peak TEA	Perf WTTF	HFS g/sht	HFS g/g	VFS g/sht	VFS g/g	Wet Burst Strength	WB Peak BEA
A	131.43	236.03	183.73	2.21	142.45	5.4	4.3	7.9	7.50	15.75	4.00	8.35	33.50	0.5
B	44.11	101.82	72.97	0.01	209.35	10.3	11.9	21.8	6.20	19.40	2.60	8.10	23.75	0.3
C	37.44	84.90	61.17	0.08	143.60	6.6	5.3	9.6	6.70	20.95	2.85	8.90	39.90	0.6
D	19.48	32.46	25.97	0.13	152.75	9.0	7.9	14.6	3.80	18.50	1.60	7.75	2.80	0.0
E	91.34	239.14	165.24	2.22	291.85	8.4	14.7	26.1	6.70	13.95	3.45	7.20	10.70	3.5
F	110.87	163.89	137.38	2.90	254.85	5.5	7.7	14.2	10.70	16.70	5.70	8.85	11.55	3.3
G	151.79	178.27	165.03	2.30	284.90	5.1	8.2	14.8	9.85	15.75	4.75	7.75	9.05	2.1
H	154.89	131.90	143.39	1.94	311.70	6.6	11.7	20.7	8.60	16.80	4.25	8.35	8.10	1.8
C1	39.43	54.25	46.84	1.32	229.00	8.9	8.8	20.8	6.25	18.00	3.00	8.65	22.55	0.3
Z03	137.83	119.43	128.63	10.21	240.10	15.3	21.5	37.5	10.40	19.80	6.20	11.80	42.30	0.67
18	192.38	183.39	187.88	8.33	193.23	8.9	10.7	18.1	9.73	18.50	5.73	10.97	25.87	0.40
19	191.62	160.41	176.01	7.80	161.23	8.8	8.6	14.3	10.07	19.37	5.80	11.13	23.70	0.33
20	65.58	103.38	84.48	7.14	175.93	7.8	8.2	13.7	9.70	17.70	5.73	10.43	28.87	0.47
21	61.64	93.80	77.72	7.73	156.53	6.3	6.1	10.0	9.77	18.60	5.67	10.80	25.00	0.40
22	62.86	95.79	79.32	7.01	205.87	10.3	12.6	21.7	10.13	19.40	5.43	10.40	31.57	0.47

FIG. 18-3 (Cont'd)

Sample ID	CD Wet Tensile Strength - Finch	CD Wet Peak Elongation - Finch	CD Wet Peak TEA - Finch	MD Wet Tensile Strength - Finch	MD Wet Peak Elongation - Finch	MD Wet Peak TEA - Finch	Total Wet Tensile - Finch	SST	Stack Comp-ressibility	Resilient Bulk	Stack Comp-ressibility x Resilient Bulk	TS7 Avg	TS750 Avg	Plate Stiff-ness
Z01	22.20	13.27	2.20	41.97	12.57	2.97	64.17	0.42	33.98	87.37	2969.66	6.88	30.05	3.34
1	19.10	9.63	1.43	42.13	22.27	2.90	61.23	0.34	35.68	86.18	3074.86	8.32	49.77	3.23
2	16.47	7.73	1.07	31.20	10.57	2.10	47.67	0.38	34.86	87.00	3033.26	7.82	40.58	3.89
3	15.40	6.30	0.83	31.50	10.17	2.07	46.90	0.31	33.95	85.90	2916.21	7.58	39.87	3.66
4	14.33	7.80	1.00	31.83	9.67	1.93	46.17	0.32	34.37	84.21	2894.78	7.59	45.98	3.80
5	21.90	8.80	1.43	40.67	9.93	2.30	62.57	0.46	36.55	87.43	3196.59	8.83	46.67	4.11
6	15.30	7.33	1.00	29.53	10.10	1.97	44.83	0.59	34.27	86.67	2970.02	9.33	44.74	4.41
7	24.85	16.35	2.70	31.80	12.50	2.30	56.65		18.88	61.89	1176.99	8.92	28.41	3.34
8	23.50	10.55	1.80	41.55	12.00	2.70	65.05		15.31	61.18	934.23	8.30	33.45	3.92
9	20.25	11.60	1.75	34.60	10.10	1.90	54.85		18.19	63.90	1164.66	9.69	31.64	4.05
10	25.35	12.40	2.20	35.30	10.95	2.35	60.65		18.22	66.64	1213.65	10.06	32.82	4.01
11	16.95	12.65	1.70	24.05	12.85	2.20	41.00		16.74	63.70	1074.26	10.05	29.44	4.19
12	22.30	15.40	2.35	30.40	13.95	2.65	52.70		17.83	67.88	1208.22	10.86	30.41	4.74
13	19.75	14.00	2.10	33.40	11.90	2.35	53.15		17.96	65.45	1172.94	8.76	30.76	3.69
Z02	18.17	11.13	1.63	43.47	13.23	3.13	61.63	0.70	34.66	62.45	2164.58	8.19	26.57	3.77
14	18.97	10.47	1.53	41.07	12.03	2.83	60.03	0.63	36.62	62.15	2276.00	8.62	33.23	3.64
15	9.47	6.30	0.73	20.27	9.40	1.33	29.73	0.65	35.44	64.06	2270.58	9.24	27.32	4.19
16	7.40	3.03	0.37	11.80	5.90	0.77	19.20	0.60	35.10	63.06	2213.23	9.12	30.08	4.37
17	15.57	6.83	0.93	34.70	12.30	2.60	50.27	0.56	35.58	62.40	2220.01	9.66	32.35	4.25

FIG. 18-4

Sample ID	CD Wet Tensile Strength - Finch	CD Wet Peak Elongation - Finch	CD Wet Peak TEA - Finch	MD Wet Tensile Strength - Finch	MD Wet Peak Elongation - Finch	MD Wet Peak TEA - Finch	Total Wet Tensile - Finch	SST	Stack Comp-ressibility	Resilient Bulk	Stack Comp-ressibility x Resilient Bulk	TS7 Avg	TS750 Avg	Plate Stiff-ness
A	26.80	8.80	1.70	57.60	9.90	2.95	84.40	0.31	26.60	51.61	1373.40	13.91	41.57	3.90
B	19.95	7.40	1.15	42.45	12.40	3.15	62.40	0.14	15.20	60.93	926.53	16.89	18.24	1.25
C	14.95	7.05	0.90	31.95	10.65	2.15	46.90	0.19	13.34	53.15	708.96	17.98	26.03	0.94
D	5.55	5.45	0.15	9.10	1.90	0.30	14.65	0.07	23.10	58.95	1361.98	36.38	108.43	0.98
E	9.60	2.85	1.30	20.40	6.20	3.55	30.00		14.90	45.27	674.26	21.38	52.97	3.29
F	10.00	3.55	1.65	24.55	7.10	4.85	34.55		19.72	44.67	881.28	18.34	47.86	2.41
G	8.00	2.35	1.15	23.45	5.95	3.90	31.45		19.04	44.69	850.91	14.89	39.41	3.06
H	6.50	1.30	0.95	19.35	4.55	2.60	25.85		23.20	49.65	1152.00	17.44	35.30	3.55
C1	15.25	6.20	0.80	30.10	9.35	1.85	45.35							
Z03	22.73	13.70	2.30	45.43	12.87	3.23	68.17	0.57	40.65	59.45	2417.34	7.24	29.12	3.60
18	15.57	8.23	1.10	34.37	12.50	2.70	49.93	0.48	36.20	60.83	2202.88	8.13	27.82	3.82
19	15.03	8.33	1.13	31.53	11.20	2.30	46.57	0.47	36.86	61.08	2251.49	8.05	29.21	3.53
20	17.97	9.57	1.40	36.37	15.20	3.20	54.33	0.37	36.21	63.74	2307.99	7.19	47.62	2.94
21	17.87	8.43	1.20	29.43	13.07	2.50	47.30	0.40	37.99	64.21	2439.52	7.04	48.86	2.52
22	20.70	10.17	1.57	36.80	13.50	2.93	57.50	0.44	37.73	65.38	2467.13	7.60	49.06	2.72

FIG. 18-4 (Cont'd)

Sample ID	Slip-Stick CoF Avg	Kinetic-COF Avg	Density g/cc	Bulk cc/g	Roll Bulk cc/g	Roll Compressibility %	Roll Firmness mm	Weight Weighted Mean Fiber Length mm	Coarseness mg/m	Perf Tensile/ Peak Tensile	Dry Tensile Ratio
Z01	285.34	0.80	0.087	11.50						0.43	2.14
1	332.38	0.82	0.077	12.93						0.35	1.80
2	308.77	0.86	0.082	12.26						0.31	1.74
3	342.71	0.87	0.081	12.35						0.30	1.73
4	316.15	0.88	0.086	11.67						0.31	1.77
5	326.92	0.86	0.080	12.43						0.29	1.88
6	357.56	0.92	0.082	12.12						0.26	1.67
7	368.10	0.88	0.080	12.48						0.38	1.42
8	358.48	0.89	0.087	11.53						0.38	1.56
9	382.46	0.82	0.078	12.83						0.34	1.75
10	375.61	0.84	0.077	12.94						0.42	1.50
11	407.54	0.84	0.083	12.02						0.45	1.39
12	410.47	0.87	0.074	13.52						0.39	1.31
13	405.90	0.87	0.080	12.53						0.36	1.61
Z02	383.26	0.93	0.079	12.73	12.13	4.59		1.56	0.094	0.52	1.96
14	322.25	0.91	0.079	12.69	11.79	4.21	9.75	1.42	0.086	0.50	1.85
15	332.95	0.86	0.078	12.74	11.87	4.38		1.14	0.082	0.44	2.13
16	363.84	0.88	0.080	12.45	11.64	4.20	9.78	0.95	0.074	0.42	1.58
17	432.37	0.85	0.080	12.48	12.20	4.58	10.09	0.85	0.077	0.42	1.74

FIG. 18-5

Sample ID	Slip-Stick CoF Avg	Kinetic-COF Avg	Density g/cc	Bulk cc/g	Roll Bulk cc/g	Roll Compressibility %	Roll Firmness mm	Weight Weighted Mean Fiber Length mm	Coarseness mg/m	Perf Tensile/ Peak Tensile	Dry Tensile Ratio
A	548.51	0.86	0.092	10.91	10.89	6.85	10.75	0.79	0.074	0.20	2.32
B	580.66	0.84	0.087	11.54	10.85	5.03	10.04	0.80	0.072	0.31	2.33
C	543.74	0.82	0.097	10.26	11.58	6.58	11.97	0.79	0.081	0.31	2.36
D	990.03	0.89	0.051	19.76	13.42	7.59	11.41	0.82	0.078	0.41	1.92
E	599.82	0.82	0.115	8.69	7.45	2.50		1.28	0.089	0.33	2.00
F	579.65	0.92	0.123	8.12	7.28	2.92	6.26	1.26	0.082	0.33	2.37
G	558.89	0.87	0.122	8.17	6.99	2.31	6.21	1.11	0.084	0.31	2.95
H	583.01	0.87	0.095	10.54	8.98	3.06	7.00	0.94	0.083	0.35	2.70
C1			0.096	10.38	10.35	5.28	9.93	0.82	0.072	0.36	2.75
Z03	382.10	0.94	0.090	11.12	11.61	5.10	10.06	1.35	0.091	0.65	1.90
18	352.92	0.89	0.091	11.05	11.39	4.56	9.61	0.92	0.073	0.58	1.63
19	334.90	0.95	0.088	11.40	11.53	4.36	9.77	0.85	0.071	0.49	1.72
20	429.46	0.93	0.085	11.74	11.17	3.78	8.62	0.90	0.073	0.52	1.54
21	412.81	0.94	0.089	11.27	11.33	3.80	8.61	0.85	0.071	0.51	1.55
22	398.26	0.94	0.079	12.59	11.79	3.98	9.13	0.94	0.079	0.53	1.56

FIG. 18-5 (Cont'd)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2025/013484

A. CLASSIFICATION OF SUBJECT MATTER

INV. D21H11/12 D21H27/00 D21H27/30
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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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IP OFFICE TYPE	⚠			DE			112023001835			1) The Procter & Gamble Company, Cincinnati,				04/06/2023			US 63456020	DE 112023001835 T5		0
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EP																	US 63329222			
CN																	US 63330077			
KR																	US 63353183			
JP																	US 63329718			
US																	US 63456020	US 20230320541 A1		0
Non-IP5 Offices	⚠			GB			202414689			1) YOUNG, ChristopherMichael	Sanitary Tissue Product Rolls			04/06/2023			US 63329222			
							Refresh Dossier			2) SHEEHAN, JeffreyGlen	Comprising Non-wood Fibers						US 18131392			
										3) KIEN, KathrynChristian							US 63330077			
										1) The Procter & Gamble Company,							US 63353183			
																	US 63329718			
																	US 63456020	GB 202414689 D0		0
																	US 63329222	GB 2632071 A		0
																	US PCT/US23/17658			
																	US 63330077			
																	US 63353183			
																	US 63329718			
																	US 63456020	GB 202414688 D0		0
																	US PCT/US23/17660GB 2632210 A			0
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																	US 63353183			
																	US 63329718			

 0	Office  0	Application  0	Assignee	Title  0	App. Date  0	Priority #	Pub. #  0
 0	US	18131387 View Dossier (details/US/18131387/A/126048) (/details/US/18131387/A/67710/true)	1) KIEN, KathrynChristian 2) YOUNG, ChristopherMichael 3) SHEEHAN, JeffreyGlen 4) OSTENDORF, WardWilliam	Sanitary Tissue Product Towels Comprising Non- wood Fibers	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718 US 18131387	US 20230323605 A1 0
	DE	112023001845 Refresh Dossier	1) The Procter & Gamble Company, Cincinnati,		04/06/2023	US 63456020 US PCT/US23/17659 US 63329222 US 63330077 US 63353183 US 63329718	DE 112023001845 T5 0
 0	US	18131384 View Dossier (details/US/18131384/A/119879) (/details/US/18131384/A/117428/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) KIEN, KathrynChristian 4) OSTENDORF, WardWilliam	Premium Sanitary Tissue Products Comprising Non- wood Fibers	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718 US 18131384	US 20240110336 A1 0
	DE	112023001829 Refresh Dossier	1) The Procter & Gamble Company, Cincinnati,		04/06/2023	US 63456020 US 63329222 US PCT/US23/17658 US 63330077 US 63353183 US 63329718	DE 112023001829 T5 0
 0	US	18131382 View Dossier (details/US/18131382/A/125899) (/details/US/18131382/A/79424/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) OSTENDORF, WardWilliam	Characteristics of Non-wood Fibers and the Sanitary Tissue Products Comprising Them	04/06/2023	US 63456020 US 63329222 US 18131382 US 63330077 US 63353183 US 63329718	US 20230320539 A1 0
 0	US	18131383 View Dossier (details/US/18131383/A/78114) (/details/US/18131383/A/95713/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) KIEN, KathrynChristian 4) OSTENDORF, WardWilliam	Soft Sanitary Tissue Products Comprising Non- wood Fibers	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718 US 18131383	US 20230323604 A1 0

 0	Office  0	Application  0	Assignee	Title  0	App. Date  0	Priority #	Pub. #  0
 0	US	18131381 View Dossier (details/US/18131381/A/113254) (/details/US/18131381/A/81567/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) KIEN, KathrynChristian 4) OSTENDORF, WardWilliam 5) WEISMAN, PaulThomas	Sanitary Tissue Products Comprising Non- wood Fibers and Having Improved Formation	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 18131381 US 63329718	US 20230323598 A1 0
 0	CA	3195408 View Dossier (details/CA/3195408/A/90679) (/details/CA/3195408/A/82465/true)	1) THE PROCTER & GAMBLE COMPANY,	SANITARY TISSUE PRODUCTS COMPRISING NON-WOOD FIBERS AND HAVING IMPROVED FORMATION	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	CA 3195408 A1 0
 0	US	PCT/US23/17660 View Dossier (details/US/PCTUS2317660/W/68647) (/details/US/PCTUS2317660/W/79329/true)	1) YOUNG, CHRISTOPHERMICHAEL 2) OSTENDORF, WARDWILLIAM 3) KIEN, KATHRYNCHRISTIAN 4) SHEEHAN, JEFFREYGLEN	SANITARY TISSUE PRODUCTS COMPRISING ONCE-DRIED FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	WO 2023196451 A1 0
 0	US	18131388 View Dossier (details/US/18131388/A/116429) (/details/US/18131388/A/72057/true)	1) YOUNG, ChristopherMichael 2) SHEEHAN, JeffreyGlen 3) KIEN, KathrynChristian 4) OSTENDORF, WardWilliam	Sanitary Tissue Products Comprising Once- Dried Fibers	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 18131388 US 63329718	US 20230320540 A1 0
 0	CA	3195396 View Dossier (details/CA/3195396/A/115004) (/details/CA/3195396/A/128200/true)	1) THE PROCTER & GAMBLE COMPANY,	SANITARY TISSUE PRODUCT ROLLS COMPRISING NON-WOOD FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	CA 3195396 A1 0

 0	Office  0	Application  0	Assignee	Title  0	App. Date  0	Priority #	Pub. #  0
 0	CA	3195498 View Dossier (details/CA/3195498/A/73714) (/details/CA/3195498/A/130751/true)	1) THE PROCTER & GAMBLE COMPANY,	SANITARY TISSUE PRODUCT TOWELS COMPRISING NON-WOOD FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	CA 3195498 A1 0
 0	US	PCT/US23/17658 View Dossier (details/US/PCTUS2317658/W/72533) (/details/US/PCTUS2317658/W/106506/true)	1) YOUNG, CHRISTOPHERMICHAEL 2) OSTENDORF, WARDWILLIAM 3) KIEN, KATHRYNCHRISTIAN 4) SHEEHAN, JEFFREYGLEN	SOFT SANITARY TISSUE PRODUCTS COMPRISING NON-WOOD FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	WO 2023196449 A1 0
 0	US	PCT/US23/17659 View Dossier (details/US/PCTUS2317659/W/129288) (/details/US/PCTUS2317659/W/71613/true)	1) YOUNG, CHRISTOPHERMICHAEL 2) OSTENDORF, WARDWILLIAM 3) KIEN, KATHRYNCHRISTIAN 4) SHEEHAN, JEFFREYGLEN	PREMIUM SANITARY TISSUE PRODUCTS COMPRISING NON-WOOD FIBERS	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	WO 2023196450 A1 0
 0	CA	3195390 View Dossier (details/CA/3195390/A/113978) (/details/CA/3195390/A/124713/true)	1) THE PROCTER & GAMBLE COMPANY,	CHARACTERISTICS OF NON-WOOD FIBERS AND THE SANITARY TISSUE PRODUCTS COMPRISING THEM	04/06/2023	US 63456020 US 63329222 US 63330077 US 63353183 US 63329718	CA 3195390 A1 0
 0	GB	202414690 Refresh Dossier	1) The Procter & Gamble Company,		04/06/2023	US 63456020 US PCT/US23/17659GB 2631895 A 0 US 63329222 US 63330077 US 63353183 US 63329718	GB 202414690 D0 0

 0	Office  0	Application  0	Assignee	Title  0	App. Date  0	Priority #	Pub. #  0
 0	US	18209510	1) SCHWERTDFEGER, KatherineL.	ARRAYS COMPRISING	06/14/2023	US 63456020	US 20230404332 A1 0
		View Dossier	2) FUNG, JoshuaThomas	HIGH TIER AND LOWER TIER		US 63472379	
		(details/US/18209510/A/107317)	3) SHEEHAN, JeffreyGlen	SUSTAINABLE		US 63375858	
		(/details/US/18209510/A/74326/true)	4) OTERO, Marlene	SANITARY TISSUE PRODUCTS		US 18209510	
			5) WEISMAN, PaulThomas			US 63353183	
			6) YOUNG, ChristopherM.			US 63353167	
			7) OSTENDORF, WardWilliam				
 0	US	18209506	1) SCHWERTDFEGER, KatherineL.	ARRAYS OF SANITARY TISSUE PRODUCTS	06/14/2023	US 63456020	US 20230406608 A1 0
		View Dossier	2) FUNG, JoshuaThomas	COMPRISING		US 18209506	
		(details/US/18209506/A/77113)	3) SHEEHAN, JeffreyGlen	NON-WOOD(S)		US 63472379	
		(/details/US/18209506/A/73798/true)	4) OTERO, Marlene			US 63375858	
			5) WEISMAN, PaulThomas			US 63353183	
			6) YOUNG, ChristopherM.			US 63353167	
			7) OSTENDORF, WardWilliam				
 0	US	18209509	1) SCHWERTDFEGER, KatherineL.	DIGITAL ARRAYS COMPRISING	06/14/2023	US 63456020	US 20230406610 A1 0
		View Dossier	2) FUNG, JoshuaThomas	SUSTAINABLE		US 63472379	
		(details/US/18209509/A/113107)	3) SHEEHAN, JeffreyGlen	SANITARY TISSUE PRODUCTS		US 63375858	
		(/details/US/18209509/A/74515/true)	4) WEISMAN, PaulThomas			US 63353183	
			5) YOUNG, ChristopherM.			US 63353167	
			6) OSTENDORF, WardWilliam			US 18209509	
			7) KIEN, KathrynChristian				

0	Office 0	Application 0	Assignee	Title 0	App. Date 0	Priority #	Pub. # 0
0	US	18209508	1) SCHWERTFEGER, KatherineL.	SANITARY TISSUE PRODUCT	06/14/2023	US 63456020	US 20230406609 A1 0
		View Dossier (details/US/18209508/A/95475)	2) FUNG, JoshuaThomas	PACKAGES CONVEYING		US 18209508 US 63472379 US 63375858	
		(/details/US/18209508/A/107332/true)	3) SHEEHAN, JeffreyGlen	SUSTAINABILITY		US 63353183 US 63353167	
			4) OTERO, Marlene				
			5) WEISMAN, PaulThomas				
			6) YOUNG, ChristopherM.				
			7) OSTENDORF, WardWilliam				
			8) KIEN, KathrynChristian				
0	US	PCT/US23/68392	1) SCHWERTFEGER, KATHERINEL.	SANITARY TISSUE PRODUCT	06/14/2023	US 63456020	WO 2023245028 A1 0
		View Dossier (details/US/PCTUS2368392/W/87048)	2) FUNG, JOSHUA THOMAS	PACKAGES CONVEYING		US 63472379 US 63375858 US 63353183	
		(/details/US/PCTUS2368392/W/109381/true)	3) OTERO, MARLENE	SUSTAINABILITY		US 63353167	
			4) KIEN, KATHRYNCHRISTIAN				
			5) WEISMAN, PAULTOMAS				
			6) YOUNG, CHRISTOPHERM.				
			7) OSTENDORF, WARDWILLIAM				
			8) SHEEHAN, JEFFREYGLEN				
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
12/02/2025 09:58:32 AM Z ET

ATTORNEY DOCKET #
16255M3

Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
 under 35 USC 111(a)

PATENT # -

CONFIRMATION # 7685

FILED BY Tamara Gozdiff

PATENT CENTER # 73399236

FILING DATE 04/06/2023

CUSTOMER # 27752

FIRST NAMED INVENTOR Christopher Michael YOUNG

CORRESPONDENCE ADDRESS -

AUTHORIZED BY Richard Alexander

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
16255M3-ISSUE-Fee dated 09-02-25.pdf	1	Issue Fee Payment (PTO-85B)	350 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
16255M3-ISSUE-Fee dated 09-02-25.pdf	92DECFA5DFD532CC8634D7503721875B363B57B5480E49E35 4A3E03E09749E7E06ECCB1C6D23029625A5DE238DC49994A 932FB303F376B38998A4AC3AEF94CEA

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Kimberly Clark EX1002, p. 4907
PGR2026-00078

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New International Application Filed with the USPTO as a Receiving Office

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Commissioner for Patents
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Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

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27752 7590 09/02/2025
THE PROCTER & GAMBLE COMPANY
GLOBAL IP SERVICES
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CINCINNATI, OH 45202

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Tamara R. Gozdiff	(Typed or printed name)
/Tamara R. Gozdiff/	(Signature)
December 2, 2025	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/131,383	04/06/2023	Christopher Michael YOUNG	16255M3	7685

TITLE OF INVENTION: Soft Sanitary Tissue Products Comprising Non-wood Fibers

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1290	\$0.00	\$0.00	\$1290	12/02/2025

EXAMINER	ART UNIT	CLASS-SUBCLASS
FORTUNA, JOSE A	1748	162-148000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

Richard L. Alexander

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

The Procter & Gamble Company

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Cincinnati, OHIO

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government4a. Fees submitted: ☒ Issue Fee ☒ Publication Fee (if required)

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☐ Applicant certifying micro entity status. See 37 CFR 1.29☐ Applicant asserting small entity status. See 37 CFR 1.27☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

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Authorized Signature /RLA/Date Dec. 2, 2025Typed or printed name Richard L. AlexanderRegistration No. 52463



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ELECTRONIC PAYMENT RECEIPT

APPLICATION #
18/131,383

RECEIPT DATE / TIME
12/02/2025 09:58:32 AM Z ET

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16255M3

Title of Invention

Soft Sanitary Tissue Products Comprising Non-wood Fibers

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 7685

FILED BY Tamara Gozdiff

PATENT CENTER # 73399236

AUTHORIZED BY Richard Alexander

CUSTOMER # 27752

FILING DATE 04/06/2023

CORRESPONDENCE
ADDRESS -

FIRST NAMED
INVENTOR Christopher Michael YOUNG

Payment Information

PAYMENT METHOD
DA / 162480

PAYMENT TRANSACTION ID
E2025B2059118832

PAYMENT AUTHORIZED BY
Tamara Gozdiff

PRE-AUTHORIZED ACCOUNT
162480

PRE-AUTHORIZED CATEGORY
37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)

FEE CODE	DESCRIPTION	ITEM PRICE(\$)	QUANTITY	ITEM TOTAL(\$)
1501	UTILITY ISSUE FEE	1290.00	1	1290.00
TOTAL AMOUNT:				\$1,290.00

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New Applications Under 35 U.S.C. 111

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Kimberly Clark EX1002, p. 4910
PGR2026-00078

Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/131,383	01/06/2026	12516475	16255M3	7685

27752 7590 12/23/2025
THE PROCTER & GAMBLE COMPANY
GLOBAL IP SERVICES
CENTRAL BUILDING, C9
ONE PROCTER AND GAMBLE PLAZA
CINCINNATI, OH 45202

ISSUE NOTIFICATION

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Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 237 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Center (<https://patentcenter.uspto.gov>).

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INVENTOR(s) (Please see PATENT CENTER site <https://patentcenter.uspto.gov> for additional inventors):

Christopher Michael YOUNG, Loveland, OH;
Jeffrey Glen SHEEHAN, Symmes Township, OH;
Kathryn Christian KIEN, Cincinnati, OH;
Ward William OSTENDORF, West Chester, OH;

APPLICANT(s) (Please see PATENT CENTER site <https://patentcenter.uspto.gov> for additional applicants):

The Procter & Gamble Company, Cincinnati, OH;

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/131,383	04/06/2023	Christopher Michael YOUNG	16255M3	7685
27752 7590 01/06/2026 THE PROCTER & GAMBLE COMPANY GLOBAL IP SERVICES CENTRAL BUILDING, C9 ONE PROCTER AND GAMBLE PLAZA CINCINNATI, OH 45202			EXAMINER FORTUNA, JOSE A	
			ART UNIT 1748	PAPER NUMBER
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