



(11)

EP 2 935 689 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
25.10.2017 Bulletin 2017/43

(51) Int Cl.:
D06M 15/21 ^(2006.01) **D06M 23/12** ^(2006.01)
D04H 13/00 ^(2006.01)

(21) Application number: **13865253.2**

(86) International application number:
PCT/IB2013/060305

(22) Date of filing: **21.11.2013**

(87) International publication number:
WO 2014/097017 (26.06.2014 Gazette 2014/26)

(54) **SUBSTRATES COMPRISING FROTHED BENEFIT AGENTS FOR ENHANCED SUBSTRATE BENEFITS**

SUBSTRATE MIT GESCHÄUMTEN PFLEGESTOFFEN FÜR VERBESSERTE
SUBSTRATEIGENSCHAFTEN

SUBSTRATS COMPRENANT DES AGENTS BÉNÉFIQUES MOUSSANTS POUR DES AVANTAGES
DE SUBSTRATS ACCRUS

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **18.12.2012 US 201213718709**

(43) Date of publication of application:
28.10.2015 Bulletin 2015/44

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Description**FIELD OF THE INVENTION**

5 **[0001]** The present invention relates to a creped nonwoven substrate comprising a frothed polymer and additional softness enhancers that demonstrate enhanced tactile feel, enhanced printing, a decrease in hysteresis, an increase in bulk, an increase in elasticity/extensibility, an increase in retractability, a reduction in rugosities and other beneficial product use benefits when compared to an untreated substrate.

BACKGROUND OF THE INVENTION

[0002] Absorbent nonwoven products such as paper towels, tissues, diapers, and other similar products are designed to have desired levels of bulk, softness and strength. For example, in some tissue products, softness is enhanced by a topical additive composition such as a softening agent to the outer surface(s) of a tissue web. Such additive composition may be a bonding agent that is topically applied to a substrate, such as a nonwoven, alone or in combination with creping operations. Creping may be part of a nonwoven manufacturing process wherein tissue is adhered to the hot surface of a rotating dryer drum by an additive composition. The dried tissue and additive composition are together scraped off the dryer drum via a doctor blade assembly. Creping adds bulk to tissue base sheets which in turn, increases softness as determined by hand feel. Other properties are affected as well, such as strength, flexibility, crepe folds and the like. Typically, additive compositions may be sprayed onto the dryer drum of a Yankee dryer. However, the spraying process has low chemical mass efficiency levels (40% to 70%) due to waste of the additive composition caused by a boundary layer of air near the dryer's surface and relatively high dryer temperatures. By necessity, the applicator is typically about 4 inches (101.6 mm) away from the dryer surface. Due to the high rotational speed of the dryer, the boundary layer of air near the dryer surface is pulled along creating a pressure barrier that inhibits spray particles from reaching the dryer surface.

[0003] Further, modifying any additives to include additional solid particles and short fibers that improve the overall softness of a substrate is somewhat limited. Many additional particles that can enhance the final hand feel of a substrate require mixing into the dispersion that is sprayed onto the dryer. Because many of these particles are larger than the spray nozzles, clogging of the nozzles is an issue that prevents the additive dispersion from being properly applied onto the dryer surface. Thus, a need exists for a method of applying an additive composition alone or in combination with enhanced softening particles to a dryer surface and eventually a substrate in order to provide a substrate that has improved softness.

[0004] Related art includes US2008/041543 which discloses a process for increasing the basis weight of sheet materials. US2012/164206 discloses a bacteriostatic tissue product. US2012/289917 discloses an enhanced care personal absorbent article. US2012/164200 discloses substrates comprising frothed benefit agents and a method of making the same.

SUMMARY OF THE INVENTION

40 **[0005]** In one aspect, the present invention provides a nonwoven substrate comprising a fibrous web defining a surface as claimed in claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

45 **[0006]** For the purpose of illustrating the invention, there is shown in the drawings a form that is exemplary; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is a schematic view of process steps used to create one embodiment of a froth according to the present invention.

50 FIG. 2 shows a SEM Image of untreated spunbond with printed ink.

FIG. 3 shows a SEM Image of one embodiment of the present invention wherein spunbond has been used as the substrate which has been treated according to the present invention and printed with ink.

FIG. 4 shows a graphical representation of elastic strain versus applied strain for embodiments of hydroknit materials that have been treated according to the present invention along with comparative data of an untreated substrate.

55 FIG. 5 shows a graphical representation of elastic strain versus applied strain for embodiment of spunbond materials that have been treated according to the present invention along with comparative data of an untreated substrate.

FIG. 6 is a series of SEM photographs showing the structural change of a tissue material after being treated by an embodiment of the present invention.

FIG. 7 shows the mechanical direction (MD) elastic strain versus the applied strain of an embodiment of a tissue substrate that has been treated according to the present invention along with comparative data of an untreated tissue substrate.

FIG. 8 shows the cross-directional (CD) elastic strain versus the applied strain of an embodiment of a tissue substrate that has been treated according to the present invention along with comparative data of an untreated tissue substrate.

FIG. 9 shows SEM Images of an untreated control film.

(a) shows a SEM Image of one side of the untreated control film.

(b) shows a SEM Image of the opposite side of the untreated control film.

(c) shows a SEM Image of the cross-sectional view of the untreated control film.

(d) shows a SEM Image of the cross-sectional view of an untreated control film at 5X the magnification of Fig. 9(c).

FIG. 10 shows SEM Images of a collapsed foam film layer of one embodiment of a benefit agent according to the present invention wherein such embodiment comprises a HYPOD® dispersion.

(a) shows a SEM Image of one side of the collapsed foam film layer.

(b) shows a SEM Image of the opposite side of the collapsed foam film layer.

(c) shows a SEM Image of the cross-sectional view of the collapsed foam film layer.

(d) shows a SEM Image of the cross-sectional view of the collapsed foam film layer at almost 2X the magnification of Fig. 10(c).

(e) shows a SEM Image of the cross-sectional view of the collapsed foam film layer at almost 7X the magnification of Fig. 10(c).

(f) shows a SEM Image of the cross-sectional view of the collapsed foam film layer at 25X the magnification of Fig. 10(c).

DETAILED DESCRIPTION OF THE INVENTION

[0007] While the specification concludes with the claims particularly pointing out and distinctly claiming the invention, it is believed that the present invention will be better understood from the following description.

[0008] All percentages, parts and ratios are based upon the total weight of the compositions of the present invention, unless otherwise specified. All such weights as they pertain to listed ingredients are based on the active level and, therefore, do not include solvents or byproducts that may be included in commercially available materials, unless otherwise specified. The term "weight percent" may 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".

[0009] As used herein, "comprising" means that other steps and other ingredients which 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 invention can comprise, consist of, and consist essentially of the essential elements and limitations of the invention described herein, as well as any of the additional or optional ingredients, components, steps, or limitations described herein.

[0010] "Additive composition" as used herein refers to chemical additives (sometimes referred to as chemical, chemistry, chemical composition and add-on) that are applied topically to a substrate. Topical applications in accordance with the method of the present invention may occur during a drying process, or a converting process. Additive compositions according to the present invention may be applied to any substrate (e.g. tissues or nonwovens) and may include, but are not limited to, polymer dispersions, polymer solutions or mixtures thereof.

[0011] "Airlaid web" as used herein is made with an air forming process, wherein bundles of small fibers, having typical lengths ranging from about 3 to about 52 millimeters (mm), are separated and entrained in an air supply and then deposited onto a forming screen, usually with the assistance of a vacuum supply. The randomly deposited fibers are then bonded to one another using, for example, hot air or a spray adhesive. The production of airlaid nonwoven composites is well defined in the literature and documented in the art. Examples include, but are not limited to, the DanWeb process as described in US Patent No. 4,640,810 to Laursen et al. and assigned to Scan Web of North America Inc.; the Kroyer process as described in US Patent No. 4,494,278 to Kroyer et al.; and US Patent No. 5,527,171 to Soerensen assigned to Niro Separation a/s; and the method of US Patent No. 4,375,448 to Appel et al. assigned to Kimberly-Clark Corporation, or other similar methods.

[0012] "Benefit Agents" are compositions or components that provide benefits to the overall treated substrate such as softness, smoothness, moisture, scents, and the like. Benefit agents of the present invention include, but are not limited to "additive compositions" and "enhancement components".

[0013] "Bonded Carded Web" or "BCW" refers to a nonwoven web formed by carding processes as are known to

those skilled in the art and further described, for example, in US Patent No. 4,488,928, which is incorporated herein by reference to the extent it is consistent to the present invention. In the carding process, one may use a blend of staple fibers, bonding fibers, and possibly other bonding components, such as an adhesive. These components are formed into a bulky ball that is combed or otherwise treated to create a substantially uniform basis weight. This web is heated or otherwise treated to activate any adhesive component, resulting in an integrated, lofty, nonwoven material.

[0014] "Coform" as used herein is a meltblown polymeric material to which fibers or other components may be added. In the most basic sense, coform may be made by having at least one meltblown die head arranged near a chute through which other materials are added to the meltblown materials as the web is formed. These "other materials" may be natural fibers, superabsorbent particles, natural polymer fibers (for example, rayon) and/or synthetic polymer fibers (for example, polypropylene or polyester). The fibers may be of staple length. Coform material may contain cellulosic material in an amount from about 10% by weight to about 80% by weight, such as from about 30% by weight to about 70% by weight. For example, in one embodiment, a coform material may be produced containing pulp fibers in an amount from about 40% by weight to about 60% by weight.

[0015] "Creping" as defined herein occurs when a web that is adhered to a dryer surface is scraped off with a blade, such as a doctor blade.

[0016] "Enhancement Components" of the present invention are benefit agents that are additional components that may be added to the additive composition in order to impart other tactile or additional benefits that cannot be achieved by the additive composition alone. The enhancement components include, but are not limited to, microparticles, expandable microspheres, fibers, additional polymer dispersions, scents, anti-bacterials, moisturizers, medicaments, soothers, and the like.

[0017] "Froth" as defined herein is a liquid foam. According to the present invention, when the frothable composition of the present invention is heated on the dryer's surface, it will not form a solid foam structure. Instead, when applied to a heated surface, the frothable composition turns into a substantially continuous film with air bubbles inside the film.

[0018] "Hydroentangled web" according to the present invention refers to a web that has been subjected to columnar jets of a fluid causing the web fibers to entangle. Hydroentangling a web typically increases the strength of the web. In one aspect, pulp fibers can be hydroentangled into a continuous filament material, such as a "spunbond web." The hydroentangled web resulting in a nonwoven composite may contain pulp fibers in an amount from about 50% to about 80% by weight, such as in an amount of about 70% by weight. Hydroentangled composite webs as described above are commercially available from the Kimberly-Clark Corporation under the name HYDROKNIT®. Hydraulic entangling is described in, for example, US Patent No. 5,389,202 to Everhart.

[0019] "Nonwoven" is defined herein as a class of fabrics generally produced by attaching fibers together. Nonwoven fabric is made by mechanical, chemical, thermal, adhesive, or solvent means, or any combination of these. Nonwoven manufacture is distinct from weaving, knitting, or tufting. Nonwoven fabrics may be made from synthetic thermoplastic polymers or natural polymers such as cellulose. Cellulosic tissue is one example of a nonwoven material.

[0020] "Meltblowing" as used herein is a nonwoven web forming process that extrudes and draws molten polymer resins with heated, high velocity air to form fine filaments. The filaments are cooled and collected as a web onto a moving screen. The process is similar to the spunbond process but meltblown fibers are much finer and generally measured in microns.

[0021] "Processing Aids" as used herein refer to compositions that may help in the process of forming the treated substrate of the present invention. For example, foaming agents may serve as suitable processing aids of the present invention. Additionally, creping aids may help with additional adhesion or release properties for creping the substrate from a dryer drum.

[0022] "Rugosities" as used herein describes the behavior of an elastic laminate to appear as channeled wrinkles as a result of an elastic material (film or filaments) that is pre-stretched while being attached to a non-stretchy material substrate (such as a nonwoven). Rugosities may depend on how the laminate is attached or bonded to the non-stretchy material substrate. When the laminate is relaxed or released, the substrate appears as grooved or channeled wrinkles similar to that of an accordion instrument. Such effect is common in personal care articles wherein the cuffs and waistbands are often bunched in order to provide a better fit to the wearer. Rugosities are also described in further detail according to US Patent No. 6475600 to Morman, et al, issued November 5, 2002.

[0023] "Spunbond" as used herein is a nonwoven web process in which the filaments have been extruded, drawn and laid on a moving screen to form a web. The term "spunbond" is often interchanged with "spunlaid," but the industry has conventionally adopted the spunbond or spunbonded terms to denote a specific web forming process. This is to differentiate this web forming process from the other two forms of the spunlaid web forming, which are meltblowing and flashspinning.

[0024] "Spunbond/Meltblown composite" as used herein is a laminar composite defined by a multiple-layer fabric that is generally made of various alternating layers of spunbond ("S") webs and meltblown ("M") webs: SMS, SMMS, SSMMMS, etc.

[0025] "Tissue" as used herein generally refers to various paper products, such as facial tissue, bath tissue, paper

towels, table napkins, sanitary napkins, and the like. A tissue product of the present invention can generally be produced from a cellulosic web having one or multiple layers. For example, in one embodiment, the cellulosic or "paper" product can contain a single-layered paper web formed from a blend of fibers. In another embodiment, the paper product can contain a multi-layered paper (i.e., stratified) web. Furthermore, the paper product can also be a single-or multi-ply product (e.g., more than one paper web), wherein one or more of the plies may contain a paper web formed according to the present invention.

[0026] The present invention is an alternative to the current method of spraying onto a dryer surface (e.g. the drum of a Yankee dryer or a hot calender) an aqueous dispersion or a solution of creping chemicals. In contrast to liquid chemistry, the frothed chemistry has enough structural integrity to reach the dryer surface against gravity due to significant high viscosity. By creating a frothed chemistry according to the present invention, a chemistry applicator can be placed in much closer proximity to the dryer surface. Additionally, by utilizing the frothed chemistry of the present invention, it is feasible to incorporate additional benefits that were otherwise more difficult to apply.

[0027] Another advantage of the present invention is that less energy is consumed by the dryer. The close proximity of the chemistry applicator to the dryer surface improves chemical mass efficiency (i.e., decrease waste in application process) and energy efficiency. Efficiency is increased because the air introduced into the froth of the present invention acts as a diluter. As a result, less heat is required to remove water from the frothed creping chemistry (i.e., benefit agents) during the drying process. This is an improvement over the spraying process which uses water to dilute the benefit agent.

[0028] Further, after the creping step, a layer of the benefit agent remains on the nonwoven substrate surface in order to add more bulk and softness. This increase in bulk is due to the entrapped air inside the coated layer. The enhanced softness is due to the benefit agents that can be frothed onto the dryer surface and subsequently transferred or adhered to the surface of the substrate through the creping process. Though the frothed benefit agents become a film during the drying step, not all of the air entrapped in the froth is lost during the drying step due to the higher viscosity associated with higher solid-levels in the frothed additive composition.

[0029] The "film" of the benefit agent is more appropriately and accurately described as a "collapsed foam film layer". To better understand this distinction, FIG. 9 shows the view of a traditional film (such as cast, extruded or blown film). As shown in FIG. 9a the film is relatively smooth with a few voids on one side and completely smooth on the other side as shown in FIG. 9b. In viewing the cross-sectional views of FIGS. 9c and 9d, voids of the film can be seen relatively parallel to the horizontal axis of the film. By contrast, FIG. 10 shows the view of a layer of the collapsed foam film of the present invention. Both sides (as shown in FIG. 10a and FIG. 10b) of the collapsed foam film layer show a unique cellular structure that allow it to possess a difference in both mechanical and tactile properties when compared to traditional films. FIG. 10c-FIG. 10f show magnified cross-sectional views of an embodiment of a collapsed foam film layer of the present invention. As shown, the frothed benefit layer possesses voids of air entrapped due to the froth which leads to advantages provided by the present invention. Additionally, the cellular structure in the Z direction can be easily seen wherein the voids of the layer are more perpendicular to the horizontal axis of the layer. Thus, the present invention does not just provide a film in the traditional sense of the word but provides an advantageous collapsed foam film layer via frothing and creping that provides the enhancements and improvements as described herein.

[0030] Various substrates other than tissue may be treated in accordance with the present disclosure. Examples include, but are not limited to, wet-laid webs, airlaid webs, spunbond webs, meltblown webs, coform webs, bonded & carded webs (BCW), continuous film, spunlace, film/laminate sheets, and hydroentangled webs. The benefit agent is typically applied on one side of any substrate, but could be applied to both sides as desired.

Benefit Agents

1. Additive Composition

[0031] In a desired application, the additive composition may be present at a level from about 50 mg/m² to about 10,000 mg/m², or from about 50 mg/m² to about 1000 mg/m² or from about 100 mg/m² to about 1000 mg/m². The difference between these suggested ranges is dependent on whether or not the additive composition is applied to a substrate either in-line (such as a tissue machine), or an off-line machine (such as a non-woven converting line). Additive compositions of the present invention may be in the form of a polymer dispersion or a polymer solution as set forth below.

A. Polymer Dispersions

[0032] Frothable compositions of water insoluble polymers may be in the form of dispersions. The water insoluble polymer materials that are solids, such as powder, granules, and the like, may be converted into a frothable dispersion by mixing it with water and surfactant(s) under certain processing conditions such as high pressure extrusion at an elevated temperature. The polymer dispersion may then be mixed with air and a foaming agent to convert it into a froth.

[0033] Examples of dispersions according to the present invention include, but are not limited to, a polyolefin dispersion

such as HYPOD 8510®, commercially available from Dow Chemical, Freeport, Texas, U.S.A.; polyisoprene dispersion, such as KRATON®, or styrene-ethylene/butylene-styrene (SEBS) copolymers, commercially available from Kraton Polymers U.S. LLC, Houston, Texas, U.S.A.; polybutadiene-styrene block copolymer dispersion such as Butanol®, commercially available from BASF Corporation, Florham Park, New Jersey, USA; latex dispersion such as E-PLUS®, commercially available from Wacker, Munich, Germany; polyvinyl pyrrolidone-styrene copolymer dispersion and polyvinyl alcohol-ethylene copolymer dispersion, both are available from Aldrich, Milwaukee, Wisconsin, U.S.A.

B. Polymer Solutions

[0034] Frothable compositions of water soluble polymers may also be in the form of solutions. The water-soluble polymer materials that are solids, such as powder, granules, and the like, may be dissolved into a solution. The polymer solution may then be mixed with air and a foaming agent to convert it into a froth.

[0035] Examples of polymer solutions according to the present invention include both synthetic and natural based water soluble polymers. The synthetic water soluble polymers include, but are not limited to, polyalcohols, polyamines, polyimines, polyamides, polycarboxylic acids, polyoxides, polyglycols, polyethers, polyesters, copolymers and mixtures of the listed above.

[0036] The natural based water soluble polymers include, but are not limited to, modified cellulose, such as cellulose ethers and esters, modified starch, chitosan and its salts, carrageenan, agar, gellan gum, guar gum, other modified polysaccharides and proteins, and combinations thereof. In one particular embodiment, the water soluble polymers also include: poly(acrylic acid) and salts thereof, poly(acrylate esters), and poly(acrylic acid) copolymers. Other suitable water soluble polymers include polysaccharides of sufficient chain length to form films such as, but not limited to, pullulan and pectin. For example, the water soluble polymers may contain additional monoethylenically unsaturated monomers that do not bear a pendant acid group, but are copolymerizable with monomers bearing acid groups. Such compounds include, for example, the monoacrylic esters and monomethacrylic esters of polyethylene glycol or polypropylene glycol, the molar masses (Mn) of the polyalkylene glycols being up to about 2,000, for example.

[0037] In another particular embodiment, the water soluble polymers may be hydroxypropyl cellulose (HPC) sold by Ashland, Inc. under the brand name of KLUCCEL®. The water soluble polymers can be present in the additive composition in any operative amount and will vary based on the chemical component selected as well as on the end properties that are desired. For example, in the exemplary case of KLUCCEL®, the biodegradable, water soluble polymers can be present in the additive composition in an amount of about 1% to about 75%, or at least about 1 %, at least about 5 %, or at least about 10 %, or up to about 30%, up to about 50% or up to about 75%, based on the total weight of the additive composition, to provide improved benefits. Other examples of suitable water soluble polymers include methyl cellulose (MC) sold by Ashland, Inc. under the brand name BENECEL®; hydroxyethyl cellulose sold by Ashland, Inc. under the brand name NATROSOL®; and hydroxypropyl starch sold by Chemstar (Minneapolis, Minnesota, U.S.A.) under the brand name GLUCOSOL 800®. Any of these chemistries, once diluted in water, are disposed onto a hot, non-porous dryer surface to ultimately transfer the chemistry to the web surface. The water soluble polymers in these chemistries include, but are not limited to, polyvinyl alcohol, polyethylene glycol, polyethylene oxide, hydroxypropyl starch, hydroxypropyl cellulose, and combinations thereof.

[0038] Conventional creping chemistries for tissue manufacturing may include water-soluble polymer solutions, such as an aqueous mixture comprising polyvinyl alcohol and a polyamide-epihalohydrin resin. While these conventional creping chemistries comprise water-soluble polymer solutions, these are not able to provide the benefits of the present invention, which include enhanced softness without compromising the strength of the tissue sheet.

[0039] The additive composition of the present invention may be commercially available, such as HYPOD 8510® dispersion, from the Dow Chemical Corporation and consists of water, a polyethylene-octene copolymer, and a copolymer of ethylene and acrylic acid. The polyethylene-octene copolymer may be obtained commercially from the Dow Chemical Corporation under the name AFFINITY® (type 2980I) and the copolymer of ethylene and acrylic acid may be obtained commercially from the Dow Chemical Corporation under the name PRIMACOR® (type 59081). PRIMACOR® acts as a surfactant to emulsify and stabilize AFFINITY® dispersion particles. The acrylic acid comonomer of PRIMACOR® is neutralized by potassium hydroxide to a degree of neutralization of around 80%. Therefore, in comparison, PRIMACOR® is more hydrophilic than is AFFINITY®. In a dispersion, PRIMACOR® acts as a surfactant or a dispersant. Unlike PRIMACOR®, AFFINITY®, as suspended in a dispersion, takes on a form of tiny droplets with a diameter of a few microns. PRIMACOR® molecules surround the AFFINITY® droplets to form a "micelle" structure that stabilizes the droplets. HYPOD 8510® contains about 60% AFFINITY® and 40% PRIMACOR®.

[0040] When the dispersion becomes a molten liquid on the dryer's hot surface, AFFINITY® forms a continuous phase and PRIMACOR® a dispersing phase forming islands in the AFFINITY® "ocean." This phase change is called phase inversion. However, occurrence of this phase inversion depends upon external conditions such as temperature, time, molecular weight of solids, and concentration. Ultimately, phase inversion only occurs when the two polymers (or two phases) have enough relaxation time to allow phase inversion completion. In the present invention, HYPOD 8510®

coated film retains a dispersion morphology which indicates there is an incompleteness of phase inversion. Benefits of the remaining dispersion morphology include, but are not limited to, a more hydrophilic coating layer due to the exposure of the PRIMACOR® phase; and more improved softness of the coated product due to entrapped air bubbles inside the coated HYPOD 8510® layer which provide extra bulkiness.

[0041] The diluted dispersion may have a very low viscosity (around 1 cp, just like water). A low viscosity dispersion, when applied onto a hot dryer drum, will undergo a process of water evaporation and a complete phase inversion of AFFINITY®. The resulting continuous molten film then has PRIMACOR® dispersion islands embedded therein. The film formed after completely evaporating the water is solid without any air bubbles entrapped therein. After transferring the molten film onto a the web through the creping process, the thin film covering the surface of the treated tissue is discontinuous yet interconnected, see Fig. 6c, discussed infra.

[0042] The process of the present invention may use a high solid, high viscosity dispersion of (about 10% to about 30%) and may contain a large amount of air bubbles (air volume is at least 10 times more than the dispersion volume). Desirably, the commercially available HYPOD 8510® dispersion (about 42% solids, including both AFFINITY® and PRIMACOR®) has a viscosity around about 500 cps whereas water has a viscosity of around about 1 cps. A dispersion containing about 20% HYPOD 8510® may have a viscosity of around 200 cps, a relatively high viscosity, while a dispersion having less than about 1% HYPOD 8510® may have a viscosity closer to water's viscosity (1 cp). After entrapping a high ratio of air, the viscosity of the frothed HYPOD 8510® dispersion has been increased exponentially compared to the dispersion before being frothed.

[0043] Referring to FIG. 1, when a frothed dispersion is applied onto the non-porous dryer surface 23, a limited amount of water will be quickly evaporated therefrom. It is thought that the dispersion's slow evaporation due to high solids combined with its high viscosity will prevent the AFFINITY®-PRIMACOR® dispersion from completing a phase inversion (wherein the AFFINITY® becomes continuous and the PRIMACOR® becomes a dispersion) and entrapped air from escaping. This results in a unique micro-structured molten film on the hot dryer surface.

[0044] Referring to FIG. 6, the SEM photos confirm the foregoing hypothesis. Two immediate benefits can be observed when comparing the prior art surface-treated tissues and the surface-treated tissues of the present invention. First, the method of the present invention yields a tissue that is more bulky and has a softer hand feel due to entrapment of air bubbles 21 (see FIG. 6b). Second, the tissue of the present invention has a more wettable surface due to incomplete phase inversion, which in turn results in surface exposure of the hydrophilic component.

[0045] Visually compare FIGS. 6a, 6b, 6c to FIGS. 6a', 6b', 6c'. The coated layer having dispersion beads 19 and entrapped air bubbles 21 shown in FIG. 6b, is softer than the melted film shown in FIG. 6b' as determined by the In Hand Ranking Test disclosed herein.

II. Enhancement Components

[0046] The present invention not only provides a substrate with improved softness due to the benefit agents and process described herein, but it also provides for an improved hand feel. Enhancement components are added to the dispersions of the present invention to provide a cottony/fluffy feel to the substrate instead of the silky/slippery feel that may often be felt with the use of the dispersions alone. It may be understood that the improved hand feel produced by the present invention may also include properties such as velvety, suede-like, hairy, smooth, fuzzy and like descriptors used to describe soft tactile properties. While the silky/slippery feel may be desirable for some substrates, the present invention provides other options in order that a variety of textures and aesthetics can be provided. Enhancement components of the present invention include, but are not limited to, microparticles such as silica gel particles, thermally expandable microspheres such as EXPANCEL®, fibers such as cotton linter flocks, polymer dispersions such as poly(vinylpyrrolidone-styrene), and combinations thereof. When cotton linter flocks or other types of fibers are used, they may be from about 0.1 mm fiber length to about 5 mm fiber length.

[0047] In addition to the enhancement components providing a contrasting hand feel, the enhancement components may also provide additional benefits that could not be appreciated with the use of the dispersion alone. Enhancement components of the present invention may also include fragrances, anti-bacterials, moisturizers, soothers, coloring agents, hydroxyethyl cellulose, medicaments and combinations thereof. Such components will provide an overall substrate that has improved feel from the dispersion in combination with benefits that may have not otherwise been provided without the present technology. The present invention may utilize any or a combination of enhancement components to be included within the additive composition of the present invention. For example, enhancement components may be added to a dispersion of the present invention in an amount of from about 0.5% to about 30%, from about 1% to about 20% or from about 2% to about 10%, by weight of the dispersion composition.

[0048] The enhancement components can be added into the frothed chemistry either before or after the chemistry has been frothed. In a desired application, the enhancement component level is about from about 0.5% to about 30%, or from about 1% to about 20%, or from about 2% to about 10%, based on total dry weight of the additive composition.

[0049] When enhancement components are used in combination with the additive compositions of the present inven-

tion, they allow for enhanced softness without compromising strength. For example, when facial tissue is used as the substrate of the present invention, there is an overall log odds increase of from about 0.5 to about 18 and a GMT level of from about 800 to about 1200 when compared to substrates that have not been processed in the same manner as the present invention. "GMT" as used herein refers to the combination of machine and cross-machine directions in determining tensile strength. Expanded microspheres stay on the surface of both film and tissue to contribute to hand feel improvement when consumers touch them in use conditions.

III. Processing Aids

[0050] Processing aids of the present invention include chemicals that may help in the process of forming the treated substrate of the present invention. The processing aids may slightly appear or may dissipate in the final, treated substrate. While they are included to solely aid in the process of producing the treated substrates, they may also impart slight benefits to the substrate that are desired of the present invention. For the purposes of this application, "processing aids" are those used in the process of frothing or applying the benefit agents to the substrate and are not used in the process of making the precursor substrate.

A. Foaming Agents

[0051] Most commercial foaming agents are suitable for creating the froth of the present invention. Suitable foaming agents include, but are not limited to, either low molecular or polymeric materials in liquid form. The foaming agents can be anionic, cationic or nonionic. These foaming agents can be divided into four groups depending on function:

1. Air Entrapment Agent -used to enhance a liquid's (dispersion, solution, or a mixture, etc.) capability to entrap air which can be measured by determining a "blow ratio." An exemplary list of foaming agents include but is not limited to potassium laurate, sodium lauryl sulfate, ammonium lauryl sulfate, ammonium stearate, potassium oleate, disodium octadecyl sulfosuccinimate, hydroxypropyl cellulose, etc.
2. Stabilization Agent - used to enhance stability of froth's air bubbles against time and temperature; examples include, but are not limited to, sodium lauryl sulfate, ammonium stearate, hydroxypropyl cellulose, etc.
3. Wetting Agent - used to enhance the wettability of a film-coated dried surface. Examples include, but are not limited to, sodium lauryl sulfate, potassium laurate, disodium octadecyl sulfosuccinimate, etc.
4. Gelling Agent - used to stabilize air bubbles in the froth by causing the additive composition to take the form of a gel which serves to reinforce cell walls. Examples include, but are not limited to, hydroxypropyl cellulose, hydroxyethyl cellulose, carboxymethyl cellulose and other modified cellulose ethers.

[0052] Some foaming agents can deliver more than one of the functions listed above. Therefore, it is not necessary to use all four foaming agents in a frothable additive composition. Selection of the foaming agents is dependent upon the chemistry of the additive composition. For example, when the additive composition comprises an anionic component, such as HYPOD 8510®, suitable foaming agents have to be selected from either anionic or non-ionic groups. If a cationic foaming agent is used to enhance frothability of an anionic additive composition, the cationic components in the foaming agent will form ionic bonds with the anionic components in the additive composition and cause both cationic foaming agent and anionic additive composition to become water insoluble due to formation of the bonds. On the other hand, if an additive composition comprises cationic components, anionic foaming agents are not suitable to use.

B. Creping Aids

[0053] Creping Aids are chemistries that are added to the benefit agents of the present invention to optimize the adhesion and release properties of the tissue substrate to the dryer surface. These fall broadly into the following groupings:

1. Adhesion Aid - used to increase adhesion of the tissue sheet to the dryer surface. Examples include, but are not limited to, polyvinyl alcohol, polyacrylate, hydroxypropyl starch, carboxymethyl cellulose, kymene, polyvinyl amine, copolymers or mixtures thereof.
2. Release Aid - used to decrease adhesion (enhance release) of the tissue sheet to (from) the dryer surface. Examples include, but are not limited to, polyethylene glycol, polypropylene glycol, polyethylene oxide, polypropylene oxide, polyolefin, fluorinated polyolefin, copolymer and blends comprising the above.
3. Curing Aid - used to hasten or retard curing of the creping package such as a plasticizer or toughener.
4. Lutensol A 65 N Iconol 24 7®, hereinafter "Lutensol®" (from the BASF® Chemical Company) may also be used to aid in creping within the present invention.

Froth Generating Process

[0054] In general, preparing frothed chemicals utilizes a system that pumps both liquid and air into a mixer. The mixer blends the air into the liquid to produce a froth which inherently includes a plurality of small air bubbles. The froth exits the mixer and flows to an applicator.

[0055] One parameter to define the quality of frothed chemistry is the blow ratio, which is defined by ratio of volume of small air bubbles entrapped by dispersion chemical to the volume of the dispersion before mixing. For example, at a blow ratio of 10:1, a dispersion flow rate of 1 liter/minute will be able to entrap 10 liters/minute of air into its liquid and produce a total froth flow rate of 11 liters per minute.

[0056] To achieve a high blow ratio, both the mechanical mixing and the frothing capability of the additive composition are determining factors. If a chemical can only hold or entrap air volume up to a blow ratio of 5, no matter how powerful a froth unit is, it won't be able to produce a stable froth having a blow ratio of 10. Any extra air beyond the blow ratio of 5 will release out of the froth system once the mechanical force is removed. In other words, any entrapped air higher than the dispersion's air containment capability will become instable. Most of such instable air bubbles will escape from the froth (debubbling) immediately after mechanical agitation is stopped.

[0057] Referring to FIG. 1, shown schematically, is a system 10 that can generate the frothed chemistry according to the present invention. To begin, frothable chemicals (e.g. HYPOD 8510®, KRATON®, and the like) are placed in a chemical tank 12. The chemical tank 12 is connected to a pump 14. It may be desirable to modify piping 13 between the chemical tank 12 and pump 14 so that one may transmit the frothable chemicals to two different sizes of pumps. Desirably the chemical tank 12 is situated at an elevated level above the pump 14 in order to keep the pump primed.

[0058] One optional small secondary pump (not shown) may be used for running the frothing process at slow speeds relative to the pump 14. The larger primary pump 14 is capable of producing flow rates up to 25 liters/minute liquid flow-rate for high application speeds and/or high amounts of additive composition. The smaller, secondary pump (not shown) is capable of liquid flow rates up to about 500 cc/min. for low application speeds and/or low additive composition.

[0059] A flow meter 16 is situated between the pump(s) 14 and a foam mixer 18. Liquid flow rates are calculated from desired additive composition, chemical solids, line-speed and applicator width. The flow rate may range from about 5:1 to about 50:1. When using the small secondary pump, its flow rate ranges from about 10 cc/min to about 500 cc/min. When using the large pump 14, its flow rate ranges from about 0.5 liter/min to about 25 liter/min. A 20 liter/min air flow meter is selected when using the small secondary pump. There is a 200 liter/min air flow meter to use when running the larger primary pump 14.

[0060] In one aspect, the foam mixer 18 is used to blend air into the liquid mixture of frothable chemicals to create small air bubbles in the froth. Air is metered into the system 10 using certain liquid flow rates and blow ratios as discussed above. Desirably, the foam mixer 18 having a size of 25.4 cm (10 inches) may be used to generate froth. One possible foam mixer 18 is a CFS-10 inch Foam Generator from Gaston Systems, Inc. of Stanley, North Carolina, U.S.A.

[0061] Desirably, the rotational speed of the foam mixer 18 is limited to about 600 rpm. The rpm speed for the mixer in this process is dependent upon the additive composition's ability to foam (i.e., its capability of entrapping air to form stable bubbles). If the additive composition foams easily, a lower rpm is generally required. If the additive composition does not foam easily, a higher rpm is generally required. The higher mixer speed helps to speed up the foam equilibrium or optimal blow ratio. A normal rpm for the mixer is about 20%-60% of the maximum rpm speed. The type of and/or amount of foam agent in addition to the additive composition also has an effect on the mixer speed requirement.

[0062] The froth is checked for bubble uniformity, stability and flow pattern. If bubble uniformity, stability and flow pattern are not to desired standards, adjustments may be made to flow rates, mixing speeds, blow ratio, and/or chemical compositions of the solutions/dispersions before directing the froth to the applicator 24.

[0063] In one aspect of the invention, HYPOD 8510®, or other chemistries to be frothed and used for creping are blended and added to the chemical tank 12. Dilute solutions of HYPOD 8510® (< 10% total solids) and other hard-to-froth chemistries generally require something added to the formulation to increase viscosity and foamability. For example, hydroxypropyl cellulose or other foaming agents or surfactants, can be used to produce a stable froth for uniform application onto the heated and non-permeable surface of a rotating drum of a dryer surface. The enhancement components, such as silica gel particles or cotton linter flocks, can be added into the additive composition in various ways, including, but not limited to: added into the additive composition before the additive composition is pumped into a frothing machine; introduced into the frothed additive composition after the additive composition is coming out of the frothing machine but before the frothed additive composition is applied onto the dryer's surface; or applied to the dryer before the substrate contacts the additive composition. When the enhancement components are introduced into the additive composition, it is necessary to constantly agitate the mixture before adding it into the frothing machine in order to prevent the solid enhancement component from being settled down at the bottom of the container. When the enhancement components are introduced into the frothed additive composition, a suitable device, which ensures a uniform mixing of the enhancement components and the frothed additive composition, is needed.

Substrates

[0064] Suitable substrate materials include but are not limited to facial tissue; uncreped through air-dried tissue (UCTAD); paper toweling; HYDROKNIT® nonwoven material from Kimberly Clark Corporation, Neenah, Wisconsin, U.S.A., wet-laid webs, airlaid webs, spunbond webs, meltblown webs, coform webs, bonded & carded webs (BCW), continuous film, spunlace, film/laminate sheets, hydroentangled webs, and all types of paper, tissue and other nonwoven products.

[0065] In the non-limiting examples discussed herein, the frothed chemistry may be applied to a nonwoven such as a tissue. As used herein, nonwovens are meant to include facial tissue, bath tissue, paper towels, spunbond, diaper or feminine care body side liners and outer covers, napkins (such as for hands and face) and the like. Tissue may be made in different ways, including but not limited to conventionally felt-pressed tissue paper; high bulk pattern densified tissue paper; and high bulk, uncompacted tissue paper. Tissue paper products made therefrom can be of a single-ply or multi-ply construction such as in US Patent Publication No. 2008/0135195. Another embodiment for forming a tissue of the present invention utilizes a papermaking technique known as uncreped through-air dried ("UCTAD"). Examples of such a technique are disclosed in US Patent No. 5,048,589 to Cook, et al.; US Patent No. 5,399,412 to Sudall, et al.; US Patent No. 5,510,001 to Hermans, et al.; US Patent No. 5,591,309 to Rugowski, et al.; and US Patent No. 6,017,417 to Wendt, et al.

Surface Coating Process

[0066] Unlike a process that sprays a dilute dispersion or solution onto a dryer surface such as a Yankee dryer surface 23 (or other suitable dryer drum surface (not shown)), the process of the present invention can apply high-solid frothed chemistry onto the dryer surface 23. In the present invention, air is used to dilute a benefit agent comprising any level of solids wherein the viscosity is within a range that can be pumped by the foaming machine. For example, having up to about 65 % of solids, up to about 50% solids, up to about 35%, or up to about 20% solids.

[0067] The high-solid coating process of the present invention may exhibit product or process benefits including but not limited to softer surface due to the unique microstructure of the collapsed foam film layer, less chemical waste due to close and direct application of the frothed chemistry, and no need to use soft or deionized water due to the high ratio of chemistry to water (for example, a chemical such as HYPOD 8510® becomes unstable when it is exposed to a large quantity of hard water, i.e., a solid level of 1% or less); and less drying energy required to dry the frothed chemistry as well as the base sheet. Additional benefits due to the addition of enhancement components include, but are not limited to uniformity of the overall Benefit Agent film coating on the nonwoven substrate; enhanced adhesion of the overall Benefit Agent coating to the nonwoven substrate; enhance mechanical strength of the overall Benefit Agent coating film; and enhanced stability of the Benefit Agent froth from the foam generator unit to the dryer surface.

[0068] The frothed benefit agents may be applied onto a substrate by two ways: an inline application or an offline application. In the inline processes a foam generator and an applicator will be incorporated into a tissue manufacturing and the frothed chemicals will be applied onto any substrate during the manufacture of same. An offline application enables application of the froth chemistry to those substrates which are produced by a non-creping process. For example, uncreped through air dried ("UCTAD") bath tissue and melt-spun nonwoven materials are suitable for use with the offline application method.

[0069] Referring to FIG. 1, in one aspect of the invention, the frothed chemicals are applied to the dryer surface 23 via an applicator 24. The froth applicator 24 is placed close to the dryer surface (0.64 cm or 1/4 inch) for uniform froth distribution onto the dryer surface 23. Such positioning allows for better, direct contact of the frothed chemistry to the dryer surface 23, especially during high speed operations.

[0070] It is most desirable to use a single parabolic applicator 24 to apply chemistry to a rotating dryer drum surface 23. However, if varying levels of chemical application are required across the width of the dryer surface due to dryer or basesheet variability, applicators (not shown) with multiple zones of miniature parabolic applicators may be used.

[0071] In general, the enhancement component makes the additive composition coating (i.e., the ocean layer) exhibit a novel and improved hand feel. For example, HYPOD 8510® may be used as an additive composition and is frothed/surface coated onto a substrate without an enhancement component. When its surface is touched, it provides significant softness improvement in comparison to the same tissue with a conventional creping chemistry. However, at the same time, it also feels slightly waxy or slippery. Some types of consumers may like this slippery feel, but others may not want to have the feel. Adding an enhancement component can change the feel without compromising the softness improvement. The hand feel obtained through this approach includes, but is not limited to, cottony, velvety, fluffy, and/or hairy. Another benefit of adding the enhancement component(s) is that the additive composition HYPOD 8510® coating layer has an improved strength which was important when the benefit agents were applied onto pre-prepared substrates, such as thermoplastic nonwovens. This improved strength enables the coated film of the benefit agents to have a uniform and complete coverage on the substrate.

[0072] Additionally, it can be shown that enhancement components and the method of application could be used to enhance surface feel, such as softness or improve surface properties, such as absorbency, friction, bulk, etc. Additionally, other surface benefits, such as scents, anti-bacterial, moisturizing, soothing agents, etc., could be applied better than the additive composition HYPOD 8510® alone could provide. Substrates comprising both HYPOD 8510® and polyvinylpyrrolidone-styrene was perceived to be almost 1.5 log odds softer (significant) than the use of HYPOD 8510® without any enhancement components.

[0073] Applicants found that the IHR results for the HYPOD 8510® frothed substrate with 6% silica gel particles as the enhancement components resulted in having the softest perceived results with a greater than 5 log-odds difference from the non-frothed substrate with conventional creping chemistry. The HYPOD 8510® frothed control without any enhancement components was next at over 4 log-odds difference. All other frothed substrates were perceived to be at least 3 log odds softer than the control non-frothed substrate.

[0074] Another benefit to adding enhancement components is the tremendous caliper increase that can be achieved while generally maintaining or having greater tensile strength than the non-frothed surface treated substrate. These substrates were all calendered at the same nip pressure for the facial converting process. The percentages listed next to the data points are the amounts of the enhancement components added based on HYPOD 8510® dry weight in the formulation before frothing. It has been shown that frothed and creped substrates showed an added increase in bulk over the non-frothed and creped substrates with the highest level increases at almost 35%. The majority of the substrates with the enhancement components increased bulk over the frothed substrate comprising only HYPOD 8510®. All of the processing conditions, such as blade types, bevel, and pressure loadings, were the same.

Creping Process

[0075] Creping is part of the substrate manufacturing process wherein the substrate is scraped off the surface of a rotating dryer (e.g. a Yankee Dryer) via a blade assembly. Creping may be done as described in US Application No. 13/330440 to Qin, et al., filed December 19, 2011

Other Benefitting Factors

[0076] Benefit agents of the present invention can be used to provide a variety of advantages that may be used to coat a substrate and provide the aforementioned advantages. Additionally, there are other advantages that the present invention provides that can be distinctly called out and described according to the following.

Enhanced Printing

[0077] A unique advantage that the present invention, as described herein, provides is that it allows for improved capabilities for printing on a nonwoven substrate. The additive composition can be applied such that it essentially forms a surface on the substrate that is more like a film so that printing is more consistent and in some instances more vibrant. For example, spunbond is appreciated for its cloth-like tactile properties or feel, however, it is not a favored substrate over a film laminate when it comes to printing as the ink tends to spread or absorb into the material reducing the ink coverage that is shown on the substrate. Of course, a film laminate is optimal for printing graphics but it is not optimal as a substrate that will be close to the skin. Prior to the present invention, a solution for printing onto a nonwoven substrate has been to adhesively laminate a printed film to the substrate. Although this has worked well, it can add to the manufacturing process and costs. The present invention therefore provides a unique compromise wherein the cloth-like tactile properties or feel of the substrate is not removed, yet it also provides a surface that allows for enhanced printing capabilities relative to the substrates. The present invention provides for a relatively smooth surface eliminating the pixilated appearance of current outer cover materials. Additionally, ink adhesion is improved. Substrates of the present invention will have improved ink coverage of at least about 25%, at least about 50% or at least about 75% when compared to an untreated substrate. The present invention provides for an improved surface area so that more of the substrate can be covered by the printed ink thereby improving the appearance or clarity of printing on the substrate as compared to an untreated substrate. Currently surface printing of outer cover laminates require the use of specialized inks to avoid potential issues with ink rub off. The present invention may accommodate any commercially available ink used for printing onto substrates. Additionally, any conventional techniques useful for printing may be used within the present invention. Such techniques may include, but are not limited to, gravure coating, offset printing, screen printing, flexography, inkjet printing, laser printing, digital printing, and the like. The dispersions of the present invention provide polar moieties that are anticipated to improve ink adhesion and thus improve printing onto nonwoven substrates directly.

[0078] FIG. 2 shows an untreated spunbond that has been printed with ink. (The white splotches are the ink printed onto the fibers of the spunbond). By comparison, FIG. 3 shows a spunbond substrate that has been treated with the benefit agent of the present invention and printed with ink. It can be seen that the treated sample (FIG. 3) has a film like

coating on the surface which gives it a greater area for the ink to cover the surface leading to enhanced visual aesthetics in terms of print clarity and vividness. Only approximately 20% of the surface was covered by ink in the untreated spunbond, FIG. 2, as compared to the 50% ink coverage of the spunbond, FIG. 3, which was treated with the present invention. This data was obtained quantifying the SEM images using image analysis software. The ink is able to adhere more consistently and smoothly on the treated substrate and therefore improves the overall look of the printing.

Enhanced Bulk and Stretch

[0079] In addition to improving the overall tactile feel of the nonwoven substrate, the present invention also enables an increase in both bulk and basis weight when compared to an untreated substrate. Without being limited by theory, bulk may be proportional to the basis weight of the fibers within the substrates of the present invention. As the basis weight increases, the corrugation of the fibers may expand the caliber of the fibers in the Z direction and thus expand the bulk of the fibers. The fibers will loft thereby increasing the bulk of the fibers. The benefit agents of the present invention may alone or in combination with certain creping mechanisms within the present invention contribute to said increase in bulk and increase in basis weight. For example, without being limited, when compared to an untreated spunbond substrate with a basis weight of 12 gsm and a bulk of 13cc/g, the present invention may allow for the spunbond to demonstrate a basis weight of 16 gsm and a bulk of 27cc/g (or a 33% and 108% increase respectively). Similarly, the creping mechanism and process can demonstrate an even greater advantage and allow the spunbond to demonstrate a basis weight of 25 gsm and 25cc/g (or a 108% and 92% increase respectively). For example, the present invention allows for nonwoven materials with varying cellulosic content to have a basis weight increase of greater than at least about 20% to about 250% as compared to an untreated substrate. For example, an untreated cellulose substrate has been shown to have a basis weight of about 56 gsm and 84% hysteresis. A nonwoven cellulose substrate of the present invention, however, can demonstrate a basis weight of about 95 gsm (about a 70% increase in basis weight) and about a 74% hysteresis. In addition to the benefit agent, such as the frothed HYPOD 8510® dispersion used in the present invention, a second component such as a nonionic surfactant like Lutensol® may further aid in the success of increasing bulk in substrates of the present invention. Lutensol® is composed of a seven mole ethylene oxide adduct of a linear lauryl myristyl alcohol that is also readily biodegradable. Additionally, with the use of a nonionic surfactant such as Lutensol®, the present invention allows for the frothed benefit agent such as the HYPOD 8510® dispersion to be used at a low add-on level yet still uniformly spread over the entire area of the substrate. The present invention, however, enables an increase in bulk without or up to about 50% addition of a nonionic surfactant such as Lutensol®. For example, about 500 mg/m² of the frothed benefit agent, for example, HYPOD 8510® dispersion may be combined with about 250 mg/m² of a nonionic surfactant such as Lutensol® in some embodiments of the present invention (i.e. a ratio of nonionic surfactant to benefit agent of about 1:2).

[0080] As used herein, the "hysteresis" value of a sample maybe determined by first stretching the sample to the desired elongation and then allowing the sample to retract in a controlled manner at the same speed. The hysteresis value is the decrease or loss of energy during this cyclic loading. The percent hysteresis (% hysteresis) is calculated by integrating the area under the loading (A_L) and unloading curve (A_{UL}); taking their difference and dividing it by the area under the loading curve. $\% \text{ Hysteresis} = (A_L - A_{UL}) * 100 / (A_L)$. These measurements are performed using a "strip elongation test which is substantially in accordance with the specifications in ASTM D5035-95. Specifically the test uses two clamps each having two jaws with each jaw having a facing in contact with the sample. The clamps hold the material in the same plane usually vertically, separated by 3 inches and move the cross head at a specific rate of extension. The sample size is 3 inches by 6 inches with a jaw facing height of 1 inch and width of 3 inches and a constant rate of 10 in/min. The specimen is clamped in a MTS (Mechanical Test Systems) electromechanical test frame which has data acquisition capability. The test is conducted at ambient condition both in cross direction and machine direction (CD & MD). Results are reported as an average of at least five specimens.

[0081] Without being limited by the data shown, FIG. 4 gives an example of the present invention, frothed and creped using hydroknit as the substrate, has about a 22% to about a 25% elastic strain at about 100% applied strain before showing any breakage. Comparatively, the control hydroknit only has about a 15% elastic strain and breaks at about 25% applied strain. Similarly, without being limited by the data shown in FIG. 5, the present invention, frothed and creped using spunbond as the substrate, has about a 27% to about a 55% elastic strain at about a 100% stretch compared to the control that only extends up to about 18% elastic strain at about a 50% stretch before break. Without being limited by the data shown, FIG. 7 shows the mechanical direction (MD) elastic stretch (the recovery) versus the applied stretch. The present invention shows an increase in stretch due to the presence of the frothed HYPOD 8510® dispersion combined with Lutensol® frothed onto a tissue substrate. The present invention shows a surprising about 30% elastic stretch at about 80% applied strain = while the basic cellulose tissue shows no more than an only about an 8% elastic stretch at about a 18% applied strain. Without being limited by the data shown, FIG. 8 shows the cross-directional (CD) strain versus the applied strain comparison of a tissue of the present invention versus an untreated tissue substrate. As shown, the present invention, using the frothed benefit agent as a HYPOD 8510® dispersion combined with Lutensol® on a

tissue substrate, has the most elastic stretch up to failure compared to the basic cellulose tissue.

[0082] Thus, while untreated nonwoven substrates may demonstrate a stretch or elongation at break, they generally do so at earlier stages of stretch. Generally, traditional untreated substrates may demonstrate of from about 8% to about 45% elongation at break. The present invention, however, allows for substrates that are treated as described herein, to demonstrate elongation at break of above about 45% elongation at break. For example, the present invention may demonstrate from about 45%, or from about 47% to about 55%, to about 80%, to about 280%, to about 337%, or to about 350% elongation at break. Particularly for certain substrates wherein the elongation at break is usually low, the present invention may provide for elongation at break to be about 25%, about 30%, about 35%, about 38%, about 45% or about 47%. Such stretch can be especially exemplified in tissue substrates according to the present invention.

[0083] Nonwoven substrates of the present invention will demonstrate at least about a 5%, at least about a 20%, at least about a 30%, at least about a 40%, at least about 50%, at least about 60%, at least about 70%, or at least about 100% decrease in hysteresis when compared to a similarly untreated substrate. It will also demonstrate at least about a 20%, at least about a 25%, at least about a 50%, at least about a 70%, at least about a 80%, at least about a 90%, at least about a 100%, at least about a 110%, at least about a 125%, at least about a 200%, at least about a 225%, or at least about a 250% increase in bulk as compared to an untreated substrate as determined by the bulk test described herein.

[0084] Again, the present invention will increase bulk and/or elasticity in a substrate with or without the presence of Lutensol® and may demonstrate bulk and/or elasticity with the frothed HYPOD 8510® dispersion alone. Without being limited, an untreated hydroknit substrate can demonstrate about 87% hysteresis and about 25% elongation at break. A hydroknit substrate of the present invention, however, can demonstrate about 67% hysteresis and about 337% elongation at break. Similarly, an untreated spunbond substrate can demonstrate 100% hysteresis and about 45% elongation at break while a spunbond substrate of the present invention can demonstrate about 40% hysteresis and about 280% elongation at break. Thus, the present invention provides enhanced versatility by allowing substrates that usually provide no elasticity to not only be able to stretch but also recover with ease and go beyond the normal and expected nature of a similar substrate that has not been processed by the present invention.

[0085] A material which has more elastic strain has more elasticity or elastic energy. Substrates of the present invention can demonstrate an increased ability to withstand stretches of at least about 25%, at least about 50%, at least about 75% or at least about 100% of applied strain as compared to an untreated substrate. While various substrates will vary, it is clear that the present invention allows for enhanced stretching compared to substrates that have not been treated accordingly. For example, untreated hydroknit can withstand about a 15% stretch with about 25% applied strain. At about 50% applied strain, that same untreated hydroknit is unable to sustain stretching without breaking. Hydroknit of the present invention can withstand about a 12% stretch at about 25% applied strain, about a 18% stretch at about a 50% applied strain, about a 21% stretch at about 75% applied strain and about a 23% stretch at about 100% applied strain. Similarly, untreated spunbond can withstand about a 10% stretch at about a 25% applied strain and about a 16% stretch at about a 50% applied strain. At about 75% applied strain, however, that same untreated spunbond is unable to sustain stretching without breaking. Spunbond of the present invention, however, can withstand about a 17% stretch at about 25% applied strain, about 36% stretch at about 50% stretch applied strain, about 46% stretch at about 75% applied strain and about 54% stretch at about 100% applied strain.

Enhanced Stretch with Elastic Retractibility

[0086] Current existing elastic film laminates such as those described in US Patent No. 8287677 to Lake et al, issued October 16, 2012, are incorporated into personal care products utilize facings that are not elastic or extensible. As a result, the elastic film (and this is also the case in elastic filament executions) must be extended prior to lamination of the facings and then relaxed. As a result of the film extension/relaxation, the elastic laminates tend to be bulkier when compared to traditional textile materials. In addition to the increase in bulk, the elastic laminate visual appearance is dictated by the bond pattern used for the lamination. The visual effect is more like an accordion with peaks and valleys bunched up in succession. Rugosities, as they are technically known, are commonly seen along the cuffs and waistbands of disposable personal care products such as, but not limited to, feminine articles, incontinence products and diapers. Consumer feedback indicates that materials that are thin, able to drape and possess cloth-like visual and tactile aesthetics are highly desired. Thus, a smoother elastic area that appears more like underwear due to the reduced or absent rugosities is more desirable. In addition, elastic film laminates rely on the non-elastic facing to drive the perception of cloth-like aesthetics (visual and tactile). Currently, approaches to modify the aesthetics of the facings of laminates rely on post-lamination treatment (for example, groove rolling) or the use of high basis weight materials (bonded carded webs in particular which are not cost effective). Thus, a facing material that is extensible, has a relatively low basis weight, and provides bulk conveys a more cloth-like appearance and tactile properties and provides an excellent opportunity to possess film laminates that mimic traditional textiles, i.e. appears more like cloth underwear. The present invention provides such a solution by providing a creped nonwoven substrate that has enhanced stretching capabilities and increased bulk to deliver a product, specifically an elastic film laminate for a product with reduced or no rugosities.

Nonwoven substrates, when combined with a non-pre-stretched elastic film to create an elastic laminate of the present invention may demonstrate an elimination of rugosities (100% reduction in rugosities) or at the very least a reduction in rugosities from at least about 5%, from at least about 10%, from at least about 25% or from at least about 50% as compared to an untreated substrate. The creped facings could also be used in work wear and Health Care garments (particularly on the body side of the garment) to enhance the perception of softness and more cloth-like texture for improved visual and tactile feel. The creping may also provide opportunities for improved moisture wicking depending on the nonwoven substrate used as the facing.

[0087] Therefore, in addition, to the aforementioned softness and bulk enhancing improvements, the present invention enables the creping of nonwoven substrates such as spunbond, bonded carded web, spunlace etc. leading to the development of structures with improvements such as higher bulk and improved tactile and visual aesthetics. Because the present invention delivers a collapsed foam film benefit agent layer on the nonwoven substrates, it helps the nonwoven retain a creped structure that should be advantageous during the lamination process. Structural evaluation of nonwoven materials, for example, spunbond, utilizing the present invention shows that the benefit agent layer coating essentially stays on one side of, specifically the surface of the nonwoven material. The benefit agent of the present invention is concentrated primarily on the peaks of the creped material which may coincide with the nonwoven material bond points. The creped nonwoven has machine direction extensibility (with some level of recovery) and a more cloth-like visual aesthetic because the appearance of the bond points (if present) on the nonwoven material is minimized and thereby reduces the rugosities. When laminated to an elastic film/filaments (without the need to pre-stretch the elastic), the result is a laminated web that can be incorporated into a product, for example, a disposable personal care article that looks and feels like underwear but provides the protection and manageable care qualities of a disposable article. Although not limited to such articles, this can be especially desirable in disposable incontinence articles where adults desire a less diaper-appearing product that bunches at the waist and legs in order to wear a product that gives a more discreet wear and feel.

[0088] The ability to crepe an extensible and retractable nonwoven material facing has been leveraged to produce non-pre-stretched (no or less rugosities) elastic laminates. To produce the laminates, the creped nonwoven materials of the present invention, for example (a spunbond material layered with the benefit agent comprising HYPOD® 8510) was laminated to one or both sides of an elastic film using adhesive. As a result, the benefit agent may be layered on the side of the creped substrate that is attached to the film to produce tactile and visual cues of laminates that are a more bulky, cloth-like material. As the film layer is not stretched and retracted, the basis weight of the film can be adjusted to meet physical property requirements rather than process requirements. The present invention provides creped nonwoven substrates produced from a variety of raw materials. Of particular interest are nonwovens produced from polypropylene, polyamides, polyesters, polyethylene, propylene/ethylene copolymers and other polyolefin blends. In addition, the level of crepe may be adjusted to provide varying degrees of MD extensibility allowing for elastic laminates with varying amounts of stretch/recovery.

[0089] Use of the creped substrates of the present invention also provides the opportunity to enhance the visual and tactile aesthetics of elastic film laminates such as those used as outer cover materials in personal care products such as, but not limited to, feminine articles, incontinence products and diapers. Adhesive lamination of the creped facings provides a more bulky, cloth-like appearance and tactile properties without requiring the use of high basis weight materials.

[0090] The present invention demonstrates improvements unfounded in substrates that have not been treated by means provided by the present invention. As described, improvements of the present invention as compared to untreated substrates may be selected from, enhanced tactile feel such as softness and the like, enhanced printing, a decrease in hysteresis, an increase in bulk, an increase in elasticity/extensibility, an increase in retractability, a reduction in rugosities, and combinations thereof.

Other Additives

[0091] The nonwoven substrates of the present invention may have additional compositions added to provide additional benefits beyond the aforementioned such as softness, printing enhancement, elasticity and bulk. Compositions may be added to the benefit agent treated substrates to aid in the overall substrate performance. Specifically, in products such as personal care articles, additional compositions may help the performance or the users experience with the product overall.

Body Fluid Rheological Modifiers

[0092] The advantage in providing a body fluid rheological modifier is to aid the nonwoven substrates of the present invention in the handling of fluids comprising blood components such as, but not limited to, feminine care products and wound dressings. Body fluid rheological modifiers include, but are not limited to mucolytic agents, mucin modifiers, red blood cell modifiers, the like, and combinations thereof. Body fluid rheological modifiers of the present invention comprise

a variety of composition or agents that are able to interact with body fluids in order to better aid body fluid interaction with the substrate. For example, mucolytic agents are known to break down critical disulfide intramolecular and/or intermolecular bonds in the mucus glycol-protein or mucin component of the menstrual fluid, thereby significantly decreasing the viscoelasticity of the mucus. Such agents have been described in US Patent No. 7687681 to DiLuccio et al, issued March 30, 2010 and are useful herein. Mucolytic agents can also modify the mucin by cleaving the protein backbone, modifying the 3D structure and decreasing the entanglement within the structure of the mucin. These include non-ionic surfactants, such as Lutenzol®, enzymes, such as Papain, and carbohydrates, such as Dextran as further described in US Patent No. 8044255 to Potts et al, issued October 25, 2011, US Patent No. 6060636 to Yahiaoui, et al., issued May 9, 2000 and US Patent No. 7928282 to Dibb, et al., issued April 19, 2011, respectively. Mucolytic agents of the present invention include, but are not limited to, L-cysteine, thioglycolates, dithiotriaccol and combinations thereof. Body fluid rheological modifiers can be used within the present invention in amounts of from about 0.1% or from about 0.2% to about 5% or to about 20% or based on the weight of the benefit agent composition.

[0093] In some substrates, the nonwoven material may exhibit a blockage of pores caused by the red blood cells which results in a decrease in the fluid intake and the wicking capabilities of the substrate. Red blood cell modifiers also exist that can reduce the viscosity as well as reduce pore blockage. These include, but are not limited to, Glucopon 220®, PLURONIC®, and those described in US Patent No. 6350711 to Potts, et al., issued February 26, 2002. Additionally, wherein the substrate is used for capturing body fluids, including, but not limited to red blood cells, the blockage of pores may result in an increase of leakage. Thus, adding such a composition to the nonwoven substrate of the present invention may enhance the end user experience thereby creating an advantageous substrate product.

Anti-Adherence Agents

[0094] In order to prevent viscoelastic fluids, such as menses and feces, from attaching to the skin, anti-adherence agents may be added. Anti-adherence agents may comprise at least one viscoelastant material, at least one anti-adherent material, or combinations thereof and may be added to the nonwoven substrate of the present invention. Anti-adherent agents are described in US Patent No. 7642396 to Schroeder et al, issued January 5, 2010. Specifically, anti-adherent agents act to prevent the adherence of menses and/or fecal material to the skin in the labial and perianal regions during and after menstruation or defecation, respectively. Suitable viscoelastant materials include, but are not limited to, linked enzymes, alkyl polyglycosides having 8-10 carbon atoms in the alkyl chain, bovine lipid extract surfactant, dextrans, dextran derivatives and combinations thereof. Suitable anti-adherent compounds of the present invention include, but are not limited to, alginic acid, beta-benzal-butyric acid, botanicals, casein, farnesol, flavones, fucans, galactolipid, kininogen, hyaluronate, inulin, iridoid glycosides, nanoparticles, perlecan, phosphorothioate oligodeoxynucleotides, poloxamer 407, polymethylmethacrylate, silicone, sulphated exopolysaccharides, tetrachlorodecaoxide, and combinations thereof. Anti-adherence agents may be added to the nonwoven substrates of the present invention in an amount of from about 0.01% to about 25% by weight of the viscoelastant material or the anti-adherent material. Other variant amounts include from about 0.05% to about 10% or from about 0.1% to about 8% or from about 0.1% to about 5% by weight of the viscoelastant material or the anti-adherent material.

Odor Control Materials

[0095] Any variety of odor control materials may be used in accordance with the present invention that are capable of imparting odor control to a nonwoven substrate. Such odor control uses are especially useful in personal care absorbent articles. For example, odor control materials may be a deodorizing mixture of an anhydrous mixture of basic, pH neutral and acidic odor absorbing particles as described in US Patent No. 5342333 to Tanzer et al., issued August 30, 1994 or US Patent No. 5364380 to Tanzer et al, issued November 15, 1994. Suitable odor control materials of the present invention may also comprise odor control systems that reduce odor by action on malodorous substances in a substrate (such as an absorbent article) or by reducing the odor by acting on the user's nose receptors as described in US Application No. 2008249490 to Carlucci et al, filed October 9, 2008. Other odor control materials of the present invention may also comprise odor control systems that provide prolonged odor control by focusing on materials with high and low volatility such as those described in US Application No. 2008071238 to Sierri et al, filed March 26, 2008. Odor control materials are further described in US Patent No. 8066956 to Do, et al, issued November 29, 2011 and US Patent No. 6926862 to Fontenot, et al, issued August 9, 2005. Odor control materials of the present invention include, but are not limited to, ammonia neutralizers, functional fragrances, chelating agents, inorganic oxide particles, such as silica, alumina, zirconia, magnesium oxide, titanium dioxide, iron oxide, zinc oxide, copper oxide, baking soda (sodium bicarbonate), activated charcoal, activated carbon, diatomaceous earths, zeolites, clays (e.g., smectite clay) and combinations thereof. Odor control materials may be present from about 2 gsm to about 80 gsm, from about 8 gsm to about 40 gsm, or from about 12 gsm to about 30 gsm depending on the basis weight of the nonwoven substrate.

EXAMPLES

[0096] The following examples further describe and demonstrate embodiments within the scope of the present invention. The examples are given solely for the purpose of illustration and are not to be construed as limitations of the present invention, as many variations thereof are possible without departing from the spirit and scope of the invention.

Example 1

[0097] Commercial HYPOD® dispersion was diluted with water to a 30% HYPOD® solid level and then frothed by the Gaston unit. The stable froth was applied to the hot drum surface of the 60 inch calendar dryer. The cured HYPOD® dispersion was creped off the dryer surface. Spunbond basesheets were creped using the froth process of the present invention as described herein. The HYPOD® coated basesheets were then printed with Cyan ink wherein 100 parts of the ink were mixed with 4.5 parts of the cross-linker by weight. The samples were hand printed using an anilox roller of 10.8 bcm (billion cubic microns).

Froth process conditions:

[0098]

% Solids in dispersion: 10-30% HYPOD 8510®
 Dryer Temperature: 260 - 300 deg F
 Dispersion Flow rate: 100 - 500 cc/min
 Mixer Speed: 20% - 60%
 Blow ratio: 5 - 30

[0099] Image analysis was performed on the SEM images to quantify surface ink coverage on both the untreated spunbond and the spunbond treated with the benefit agent of the present invention. The treated samples show higher % surface ink coverage than the untreated spunbond as shown in Table 1.

Table 1

Substrate	% Ink Coverage
Spunbond Control A (8 gsm)	14.00
Spunbond Control B (12 gsm)	17.00
Spunbond Frothed (8 gsm)	61.00

Example 2

[0100] Commercial HYPOD 8510® polyolefin dispersion was diluted with water to varied HYPOD 8510 solids levels with no or up to 50% additions of Lutensol® A 65 N ICONOL® 24 7 based on HYPOD 8510® solids. This chemistry was then frothed by the Gaston Systems foam unit and the stable froth was applied to the hot surface of a 60 inch dryer. The basesheet was then pressed onto the collapsed foam coated dryer surface, creped off the dryer surface, and wound up on a reel drum.

Basesheets namely cellulose based towel, hydroknit®, spunbond were used to create stretchy materials using the process by controlling the creping blade geometry and/or the draw ratio.

Froth process conditions:

[0101]

% Solids in dispersion: 5% -30% HYPOD 8510®
 Dryer Temperature: 230 - 300 deg F
 Dispersion Flow rate: 50- 500 cc/min
 Mixer Speed: 20 - 60%
 Blow ratio: 5 - 30

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Mechanical Testing - % Hysteresis:

[0102] Testing was performed using MTS tensile tester model # Insight Model EL1. A 3" inch wide test specimen was pulled at 10 in/min up to 20 % strain and then retracted at the same rate to 0% strain. The area under the loading and unloading curve was measured as % hysteresis as shown in tables 2 and 3. Additionally, table 3 shows elongation at break for each of the tested substrates.

Table 2

% Hysteresis for creped cellulose towel			
	Basis Weight (gsm)	% Hysteresis	
		Average	Std.Dev
Control	56	84	±0.6
Cellulose Frothed	95	74	±0.7

Table 3

% Hysteresis for creped spunbond and hydroknit and cellulose facial tissue		
	% Hysteresis	% Elongation at break
Control Hydroknit	87	25
Hydroknit A Frothed	70	153
Hydroknit B Frothed	66	337
Control Spunbond	100	45
Spunbond A Frothed	42	124
Spunbond B Frothed	40	280
Control Facial Tissue	95	29
Frothed Facial Tissue	65	47

Mechanical Testing - Elastic Energy:

[0103] Testing was performed using MTS tensile tester model # Insight Model EL1. A 3" inch wide test specimen was pulled at 10 in/min through numerous cyclic loading and unloading curves up to increasing % strains (25, 50, 75 and 100). The amount of permanent deformation was measured after each cycle according to the applied strain (in/in) for each cycle as shown in Table 4.

Table 4

Elastic Strain at given applied strain				
	Applied strain (in/in)			
	0.25	0.50	0.75	1.00
Control Hydroknit	0.15	0.00	0.00	0.00
Hydroknit A Frothed	0.12	0.18	0.21	0.23
Hydroknit B Frothed	0.10	0.17	0.22	0.25
Control spunbond	0.10	0.16	0.00	0.00
Spunbond A Frothed	0.16	0.28	0.30	0.28
Spunbond B Frothed	0.17	0.36	0.46	0.54
Control Facial Tissue	0.06	0.00	0.00	0.00

(continued)

Elastic Strain at given applied strain				
	Applied strain (in/in)			
	0.25	0.50	0.75	1.00
Frothed Facial Tissue	0.12	0.16	0.03	0.00

Example 3

[0104] Bulk was measured by quantifying the basis weight (gsm) and bulk (cc/g) by measuring the weight and the thickness of the material. The results are as shown in Table 5.

Table 5

Code Number	Basis Weight (gsm)	Bulk (cc/g)
Control Spunbond	12	13
Spunbond A Frothed	16	27
Spunbond B Frothed	25	25

TEST METHODS

(1) In-Hand Ranking Test for Tactile Properties (IHR Test):

[0105] The In-Hand Ranking Test (IHR) is a basic assessment of in-hand feel of fibrous webs and assesses attributes such as softness. This test is useful in obtaining a quick read as to whether a process change is humanly detectable and/or affects the softness perception, as compared to a control. The difference of the IHR softness data between a treated web and a control web reflects the degree of softness improvement.

[0106] A panel of testers was trained to provide assessments more accurately than an average untrained consumer might provide. Rank data generated for each sample code by the panel were analyzed using a proportional hazards regression model. This model computationally assumes that the panelist proceeds through the ranking procedure from most of the attribute being assessed to least of the attribute. The softness test results are presented as log odds values. The log odds are the natural logarithm of the risk ratios that are estimated for each code from the proportional hazards regression model. Larger log odds indicate the attribute of interest is perceived with greater intensity.

[0107] Because the IHR results are expressed in log odds, the difference in improved softness is actually much more significant than the data indicates. For example, when the difference of IHR data is 1, it actually represents 10 times ($10^1 = 10$) improvement in overall softness, or 1,000% improvement over its control. In another example, if the difference is 0.2, it represents 1.58 times ($10^{0.2} = 1.58$) or a 58% improvement.

[0108] The data from the IHR can also be presented in rank format. The data can generally be used to make relative comparisons within tests as a product's ranking is dependent upon the products with which it is ranked. Across-test comparisons can be made when at least one product is tested in both tests.

(2) Bulk Test

[0109] Sheet bulk is calculated as the quotient of the sheet caliper of a conditioned fibrous sheet, expressed in microns, divided by the conditioned basis weight, and expressed in grams per square meter. The resulting sheet bulk is expressed in cubic centimeters per gram (cc/g). More specifically, the sheet caliper is the representative thickness of a single 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" with Note 3 for stacked sheets. The micrometer used for carrying out T411 om-89 is an Emveco 200-A Tissue Caliper Tester available from Emveco, Inc., Newberg, Oregon, U.S.A. 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.

(3) Viscosity Test

[0110] Viscosity is measured using a Brookfield Viscometer, model RVDV-II+, available from Brookfield Engineering Laboratories, Middleboro, Massachusetts, U.S.A. Measurements are taken at room temperature (23 C), at 100 rpm, with either spindle 4 or spindle 6, depending on the expected viscosity. Viscosity measurements are reported in units of centipoise.

(4) Quantity of HYPOD 8510® Additive Composition Test

[0111] In one aspect of the invention, HYPOD add-on is determined by using acid digestion. Samples are wet ashed with enough concentrated sulfuric and nitric acid to destroy the carbonaceous material and isolate the potassium ions from the cellulosic matrix. The potassium concentration is then measured by atomic absorption. HYPOD 8510® add-ons are determined by referencing the potassium concentration of the HYPOD 8510® on the sample to bulk HYPOD 8510® measurements from a control HYPOD 8510® dispersion solution (LOTVB1955WC30, 3.53%).

(5) Method for Determining Content of Additive Composition in Tissue.

[0112] Samples were digested following EPA method 3010A. The method consists of digesting a known amount of material with Nitric Acid in a block digester and bringing it up to a known volume at the end of the digestion.

[0113] Analysis was performed on a flame atomic absorption spectrophotometer using EPA method 7610 dated July 1986, which is a direct aspiration method using an air/acetylene flame. The instrument used was a VARIAN AA240FS available from Aligent Technologies, Santa Clara, California, U.S.A.

[0114] The analysis was performed in the following manner: The instrument was calibrated with a blank and five standards. Calibration was followed with analyzing a second source standard to confirm the calibration standards. In this particular case, recovery was 97% (90-110% being acceptable). Next a digestion blank and a digestion standard were analyzed. In this particular case, the blank was less than 0.1 mg/l and the standard recovery was 93% (85-115% being acceptable). Samples were then analyzed and after every tenth sample a standard was run (90-110% being acceptable). At the end of entire analysis, a blank and standard were run.

(6) Basis Weight

[0115] The Basis Weight of the tissue sheet specimens was determined using a modified TAPPI T410 procedure. The pre-plied samples were conditioned at $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$. and $50 \pm 2\%$ relative humidity for a minimum of 4 hours. After conditioning a stack of 16-3"×3" pre-plied samples was cut using a die press and associated die. This represents a tissue sheet sample area of 144 in² or 0.0929 m². Examples of suitable die presses are TMI DGD die press manufactured by Testing Machines, Inc. located at Islandia, N.Y., or a Swing Beam testing machine manufactured by USM Corporation, located at Wilmington, Mass. Die size tolerances are ± 0.008 inches in both directions. The specimen stack is then weighed to the nearest 0.001 gram on a tared analytical balance. The basis weight in grams per square meter (gsm) is calculated using the following equation:

$$\text{Basis weight (conditioned)} = \text{stack wt. in grams} / (0.0929 \text{ m}^2)$$

(7) Geometric Mean Tensile Strength (GMT)

[0116] The Geometric Mean Tensile Strength (GMT) is the square root of the product of the dry machine direction (MD) tensile strength multiplied by the dry cross-machine direction (CD) tensile strength and is expressed as grams per 3 inches of sample width. The MD tensile strength is the peak load per 3 inches of sample width when a sample is pulled to rupture in the machine direction. Similarly, the CD tensile strength is the peak load per 3 inches of sample width when a sample is pulled to rupture in the cross-machine direction. The tensile curves are obtained under laboratory conditions of $23.0^{\circ}\text{C} \pm 1.0^{\circ}\text{C}$, $50.0 \pm 2.0\%$ relative humidity and after the tissue samples have equilibrated to the testing conditions for a period of not less than four hours.

[0117] The samples for tensile strength testing are cut into strips 3 inches wide (76 mm) by at least 5 inches (127 mm) long 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. SC130). The tensile tests are measured on an MTS Systems Synergie 100 run with TestWorks® 4 software version 4.08 (MTS Systems Corp., Eden Prairie, MN).

[0118] The load cell is 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 10-90% of the load cell's full scale value. The gauge length between jaws is 4 +/- 0.04 inches (102 +/-1mm). The jaws are operated using pneumatic-action and are rubber coated. The minimum grip face width is 3 inches (76 mm), and the approximate height of a jaw is 0.5 inches (13 m). The crosshead speed is 10 +/- 0.4 inches/min (254 +/-10 mm/min), and the break sensitivity is set at 65%.

[0119] The sample is placed in the jaws of the instrument, centered both vertically and horizontally. The test is then started and ends when the specimen breaks. The peak load is recorded as either the "MD tensile strength" or the "CD tensile strength" of the specimen depending on direction of the sample being tested. Ten (10) specimens per sample are tested in each direction with the arithmetic average being reported as either the MD or CD tensile strength value for the product. The geometric mean tensile strength is calculated from the following equation:

$$\text{GMT} = (\text{MD Tensile} * \text{CD Tensile})^{1/2}$$

[0120] The dimensions and values disclosed herein 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".

[0121] All documents cited in the Detailed Description of the Invention are, in relevant part, incorporated 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 invention. 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.

Claims

1. A nonwoven substrate comprising:

a fibrous web defining a surface; and

a layer of a benefit agent wherein said benefit agent is an additive composition;

wherein said benefit agent is frothed and bonded to the fibrous web surface through a creping process such that the additive composition forms a surface on the substrate which is more film like than the substrate; **characterised in that:**

said nonwoven substrate is printed and demonstrates enhanced printing when compared to an untreated substrate.

2. The nonwoven substrate of claim 1 wherein the substrate demonstrates from at least a 5% decrease in hysteresis, at least a 40% increase in bulk, and combinations thereof when compared to an untreated substrate.

3. The nonwoven substrate of claim 1 wherein the fibrous web is selected from the group consisting of tissue, through air-dried tissue, paper toweling, hydroentangled web, spunbond, meltblown, coform, bonded carded web, airlaid, laminates, paper, and composite combinations of the above.

4. The nonwoven substrate of claim 1 wherein said additive composition is a polymer dispersion selected from polyolefin dispersions, SEBS copolymer dispersions, polyisoprene dispersions, polybutadiene-styrene block copolymer dispersions, latex dispersions, polyvinyl pyrrolidone-styrene copolymer dispersions, polyvinyl alcohol-ethylene copolymer dispersions, and combinations thereof.

5. The nonwoven substrate of claim 1 wherein said benefit agent further comprises an enhancement component selected from microparticles, expandable microspheres, fibers, additional polymer dispersions, scents, anti-bacterials, moisturizers, medicaments and soothers.

6. The nonwoven substrate of claim 4 further comprising an enhancement component that is added to the polymer dispersion in an amount from 0.5% to 30%, by weight of the dispersion.

7. The nonwoven substrate of claim 1 wherein the additive composition is a water-insoluble polyolefin copolymer

selected from ethylene-acrylic acid, polyethylene-octene copolymer, and combinations thereof.

8. The nonwoven substrate of claim 1 wherein the additive composition is selected from a synthetic water-soluble polymer, a natural water-soluble polymer and mixtures thereof, preferably wherein the additive composition is a synthetic water-soluble polymer selected from polyalcohols, polyamines, polyimines, polyamides, polycarboxylic acids, polyoxides, polyglycols, polyethers, polyesters, copolymers and mixtures thereof, or wherein the additive composition is a natural water-soluble polymer selected from modified cellulose, modified starch, modified protein, chitosan, chitosan salts, carrageenan, agar, gellan gum, guar gum and combinations thereof.
9. The nonwoven substrate of claim 1 wherein the substrate exhibits improved ink coverage of at least 25% in improving the appearance of printing on said substrate, or wherein the substrate exhibits from a 20% to a 250% increase in bulk as determined by the bulk test.
10. The nonwoven substrate of claim 4 wherein a nonionic surfactant is combined with the additive composition in a ratio of about 1:2.
11. The nonwoven substrate of claim 1 wherein the substrate demonstrates an elastic strain that is able to sustain from 25% to 100% of an applied strain stretch before breaking, or wherein the substrate demonstrates above a 45% elongation at break.
12. The nonwoven substrate of claim 1 wherein the substrate is combined with a non-pre-stretched elastic film to create an elastic laminate with from 5% to 100% reduction in rugosities.
13. The nonwoven substrate of claim 1 further comprising from 0.1% to 20% of a body fluid rheological modifier, preferably wherein the body fluid rheological modifier is selected from mucolytic agents wherein said mucolytic agents are selected from L-cysteine, thioglycolates, dithiotriaccol and combinations thereof; mucin modifiers; red blood cell modifiers; and combinations thereof.
14. The nonwoven substrate of claim 1 further comprising an anti-adherent agent selected from 0.01% to 25% of at least one viscoelastant material wherein said viscoelastant material is selected from linked enzymes, alkyl polyglycosides having 8-10 carbon atoms in the alkyl chain, bovine lipid extract surfactant, dextrans, dextran derivatives and combinations thereof; at least one anti-adherent compound wherein said anti-adherent compound is selected from alginic acid, beta-benzal-butyric acid, botanicals, casein, farnesol, flavones, fucans, galactolipid, kininogen, hyaluronate, inulin, iridoid glycosides, nanoparticles, perlecan, phosphorothioate oligodeoxynucleotides, poloxamer 407, polymethylmethacrylate, silicone, sulphated exopolysaccharides, tetrachlorodecaoxide, and combinations thereof; and combinations thereof.
15. The nonwoven substrate of claim 1 further comprising from 2 gsm to 80 gsm of an odor control material.

Patentansprüche

1. Vliesstoffsubstrat, umfassend:

eine Faserstoffbahn, welche eine Oberfläche definiert; und
 eine Schicht eines Wirkstoffs, wobei der Wirkstoff eine Additivzusammensetzung ist;
 wobei der Wirkstoff aufgeschäumt und durch einen Kreppprozess mit der Faserstoffbahnoberfläche verbunden ist, sodass die Additivzusammensetzung eine Oberfläche auf dem Substrat bildet, die folienartiger ist als das Substrat; **dadurch gekennzeichnet, dass:**
 das Vliesstoffsubstrat bedruckt ist und im Vergleich zu einem unbehandelten Substrat eine verbesserte Bedruckung aufweist.

2. Vliesstoffsubstrat nach Anspruch 1, wobei das Substrat im Vergleich zu einem unbehandelten Substrat eine Abnahme der Hysterese von mindestens 5%, eine Volumenzunahme von mindestens 40% und Kombinationen davon aufweist.
3. Vliesstoffsubstrat nach Anspruch 1, wobei die Faserstoffbahn aus der Gruppe ausgewählt ist, bestehend aus Tissue, durch Luft getrocknetem Tissue, Papierhandtuchmaterial, hydro-verwirkter Bahn, Spinnvliesbahn, schmelzgeblas-

sener, Coform-, gebondeter kardierter Bahn, Airlaid-Bahn, Laminaten, Papier und zusammengesetzten Kombinationen der vorgenannten.

4. Vliesstoffsubstrat nach Anspruch 1, wobei die Additivzusammensetzung eine Polymerdispersion ist, ausgewählt aus Polyolefindispersionen, SEBS-Copolymerdispersionen, Polyisoprendispersionen, Polybutadien-Styrol-Blockcopolymer-Dispersionen, Latexdispersionen, Polyvinylpyrrolidon-Styrol-Copolymerdispersionen, Polyvinylalkohol-Ethylen-Copolymerdispersionen und Kombinationen davon.
5. Vliesstoffsubstrat nach Anspruch 1, wobei der Wirkstoff weiter eine Verbesserungskomponente umfasst, ausgewählt aus Mikropartikeln, expandierbaren Mikrokügelchen, Fasern, zusätzlichen Polymerdispersionen, Duftstoffen, antibakteriellen Mitteln, Feuchthaltemitteln, Medikamenten und reizlindernden Mitteln.
6. Vliesstoffsubstrat nach Anspruch 4, weiter eine Verbesserungskomponente umfassend, die der Polymerdispersion in einer Menge von 0,5% bis 30% des Gewichts der Dispersion zugesetzt wird.
7. Vliesstoffsubstrat nach Anspruch 1, wobei die Additivzusammensetzung ein wasserunlösliches Polyolefin-Copolymer ist, ausgewählt aus Ethylen-Acrylsäure, Polyethylen-Octen-Copolymer und Kombinationen davon.
8. Vliesstoffsubstrat nach Anspruch 1, wobei die Additivzusammensetzung aus einem synthetischen wasserlöslichen Polymer, einem natürlichen wasserlöslichen Polymer und Mischungen davon ausgewählt ist, wobei bevorzugt die Additivzusammensetzung ein synthetisches wasserlösliches Polymer ist, ausgewählt aus Polyalkoholen, Polyaminen, Polyimininen, Polyamiden, Polycarbonsäuren, Polyoxiden, Polyglykolen, Polyethern, Polyestern, Copolymeren und Mischungen davon, oder wobei die Additivzusammensetzung ein natürliches wasserlösliches Polymer ist, ausgewählt aus modifizierter Cellulose, modifizierter Stärke, modifiziertem Protein, Chitosan, Chitosansalzen, Carrageen, Agar, Gellangummi, Guargummi und Kombinationen davon.
9. Vliesstoffsubstrat nach Anspruch 1, wobei das Substrat eine verbesserte Tintenabdeckung von mindestens 25% bei der Verbesserung des Erscheinungsbildes der Bedruckung des Substrats aufweist, oder wobei das Substrat einen Volumenanstieg von 20% bis 250% aufweist, ermittelt durch den Volumentest.
10. Vliesstoffsubstrat nach Anspruch 4, wobei ein nichtionisches oberflächenaktives Mittel in einem Verhältnis von ungefähr 1:2 mit der Additivzusammensetzung kombiniert wird.
11. Vliesstoffsubstrat nach Anspruch 1, wobei das Substrat eine elastische Dehnung aufweist, die fähig ist, 25% bis 100% einer angelegten Dehnungsbeanspruchung vor Bruch standzuhalten, oder wobei das Substrat eine Bruchdehnung von über 45% aufweist.
12. Vliesstoffsubstrat nach Anspruch 1, wobei das Substrat mit einer nichtvorgestreckten elastischen Folie kombiniert wird, um ein elastisches Laminat mit einer Faltenverringern von 5% bis 100% zu erzeugen.
13. Vliesstoffsubstrat nach Anspruch 1, weiter 0,1% bis 20% eines rheologischen Körperflüssigkeitsmodifizierungsmittels umfassend, wobei bevorzugt das rheologische Körperflüssigkeitsmodifizierungsmittel aus schleimlösenden Mitteln ausgewählt ist, wobei die schleimlösenden Mittel ausgewählt sind aus L-Cystein, Thioglycolaten, Dithiotriacoll und Kombinationen davon; Mucin-Modifizierungsmitteln; rote Blutkörperchen-Modifizierungsmitteln; und Kombinationen davon.
14. Vliesstoffsubstrat nach Anspruch 1, weiter ein Antihafmittel umfassend, ausgewählt aus 0,01% bis 25% mindestens eines viskoelastischen Materials, wobei das viskoelastische Material ausgewählt ist aus vernetzten Enzymen, Alkylpolyglycosiden mit 8-10 Kohlenstoffatomen in der Alkylkette, Rinderlipidextract-Tensid, Dextranen, Dextranderivaten und Kombinationen davon; mindestens einer Antihafverbindung, wobei die Antihafverbindung ausgewählt ist aus Algensäure, Beta-Benzal-Buttersäure, pflanzlichen Stoffen, Casein, Farnesol, Flavonen, Fucanen, Galactolipid, Kininogen, Hyaluronat, Inulin, Iridoidglycosiden, Nanopartikeln, Perlecan, Phosphorthioat-Oligodeoxynucleotiden, Poloxamer 407, Polymethylmethacrylat, Silikon, sulfierten Exopolysacchariden, Tetrachlordecaoxid und Kombinationen davon; und Kombinationen davon.
15. Vliesstoffsubstrat nach Anspruch 1, weiter 2 g/m² bis 80 g/m² eines Materials zur Geruchsbekämpfung umfassend.

Revendications

1. Substrat non tissé comprenant :

une nappe fibreuse définissant une surface ; et
une couche d'un agent bénéfique dans lequel ledit agent bénéfique est une composition d'additif;
dans lequel ledit agent bénéfique est moussé et est lié à la surface de la nappe fibreuse par l'intermédiaire d'un
procédé de crêpage pour que la composition d'additif forme une surface sur le substrat qui est plus de type film
que le substrat, **caractérisé en ce que** :

ledit substrat non tissé est imprimé et montre une impression améliorée par comparaison au substrat non traité.

2. Substrat non tissé selon la revendication 1, dans lequel le substrat montre à partir d'au moins 5% de diminution de l'hystérésis, au moins 40% d'augmentation en masse, et leurs combinaisons, en comparaison au substrat non traité.

3. Substrat non tissé selon la revendication 1, dans lequel la nappe fibreuse est choisie dans le groupe constitué par une nappe de papier, une nappe de papier séchée par de l'air traversant, un papier serviette, une nappe hydro-enchevêtrée, une nappe liée au filage, une nappe fondue-soufflée, une nappe coformée, une nappe cardée liée, une nappe aéraulique, les stratifiés, le papier, et les combinaisons de composites ci-dessus.

4. Substrat non tissé selon la revendication 1, dans lequel ladite composition d'additif est une dispersion polymérique choisie parmi les dispersions de polyoléfines, les dispersions de copolymères SEBS, les dispersions de polyisoprène, les dispersions de copolymères à blocs de polybutadiène-styrène, les dispersions de latex, les dispersions de copolymères de pyrrolidone-styrène polyvinyliques, les dispersions de copolymères d'alcool-éthylène polyvinyliques, leurs combinaisons.

5. Substrat non tissé selon la revendication 1, dans lequel ledit agent bénéfique comprend en outre un composant d'amélioration choisi parmi les microparticules, les microsphères expansibles, les fibres, les dispersions de polymères additionnels les senteurs, les antibactériens, les hydratants, les médicaments et les apaisants.

6. Substrat non tissé selon la revendication 4, comprenant en outre un composant d'amélioration qui est ajouté à la dispersion de polymère en une quantité de 0,5% à 30% en poids de la dispersion.

7. Substrat non tissé selon la revendication 1, dans lequel la composition d'additif est un copolymère de polyoléfine insoluble choisi parmi l'acide éthylène-acrylique, un copolymère de polyéthylène-octène, et leurs combinaisons.

8. Substrat non tissé selon la revendication 1, dans lequel la composition d'additif est choisie parmi un polymère soluble dans l'eau synthétique, un polymère soluble dans l'eau naturel et leurs mélanges, de préférence dans lequel la composition d'additif est un polymère soluble dans l'eau synthétique choisi parmi les polyols, les polyamines, les polyimines, les polyamides, les acides polycarboxyliques, les polyoxydes, les polyglycols, les polyéthers, les polyesters, les copolymères et leurs mélanges, ou dans lequel la composition d'additif est un polymère soluble dans l'eau naturel choisi parmi la cellulose modifiée, l'amidon modifié, une protéine modifiée, le chitosane, les sels de chitosane, la carraghénane, la gélose, la gomme de gellane, la gomme de guar et leurs combinaisons.

9. Substrat non tissé selon la revendication 1, dans lequel le substrat présente une couverture accrue de l'encre d'au moins 25% par une amélioration de l'apparence de l'impression sur ledit substrat, ou dans lequel le substrat présente une augmentation de 20% à 250% dans la masse comme déterminé par l'essai en masse.

10. Substrat non tissé selon la revendication 4, dans lequel un tensioactif non ionique est combiné avec la composition d'additif en un rapport d'environ 1:2.

11. Substrat non tissé selon la revendication 1, dans lequel le substrat montre une contrainte élastique qui est capable de maintenir de 25% à 100% un étirement sous tension avant rupture, ou dans lequel le substrat montre une élongation à la rupture supérieure à 45%.

12. Substrat non tissé selon la revendication 1, dans lequel le substrat est combiné avec un film élastique non pré-étiré pour former un stratifié élastique avec une réduction de rugosités de 5% à 100%.

13. Substrat non tissé selon la revendication 1, comprenant en outre de 0,1% à 20% d'un modificateur rhéologique de fluide corporel, de préférence dans lequel le modificateur rhéologique de fluide corporel est choisi parmi les agents mucolytiques dans lequel les agents mycolytiques sont choisis parmi la L-cystéine, les thioglycolates, le dithiotriacol et leurs combinaisons ; les modificateurs de mucine ; les modificateurs de globules rouges ; et leurs combinaisons.

14. Substrat non tissé selon la revendication 1, comprenant en outre un agent anti-adhérent choisi à partir de 0,01% à 25% d'au moins un matériau visco-élastique dans lequel le matériau visco-élastique est choisi parmi les enzymes liées, les polyglycosides d'alkyle ayant de 8 à 10 atomes de carbone dans la chaîne alkyle, un tensioactif d'extrait lipidique bovin, les dextranes, les dérivés de dextrane et leurs combinaisons; au moins un composé anti-adhérent dans lequel ledit composé anti-adhérent est choisi parmi l'acide alginique, l'acide bêta-benzalbutyrique, les substances végétales, la caséine, le farnésol, les flavones, les fucanes, un galactolipide, le kininogène, un hyaluronate, l'inuline, les glycosides d'iridoïde, les nanoparticules, le perlécane, les oligodésoxynucléotides de phosphorothionate, le poloxamère 407, le poly(méthylméthacrylate), le silicone, les exopolysaccharides sulfatés, le tétrachlorodécaoxyde, et leurs combinaisons ; et leurs combinaisons.

15. Substrat non tissé selon la revendication 1, comprenant en outre de 2 g/m² à 80 g/m² d'un matériau régulant les odeurs.

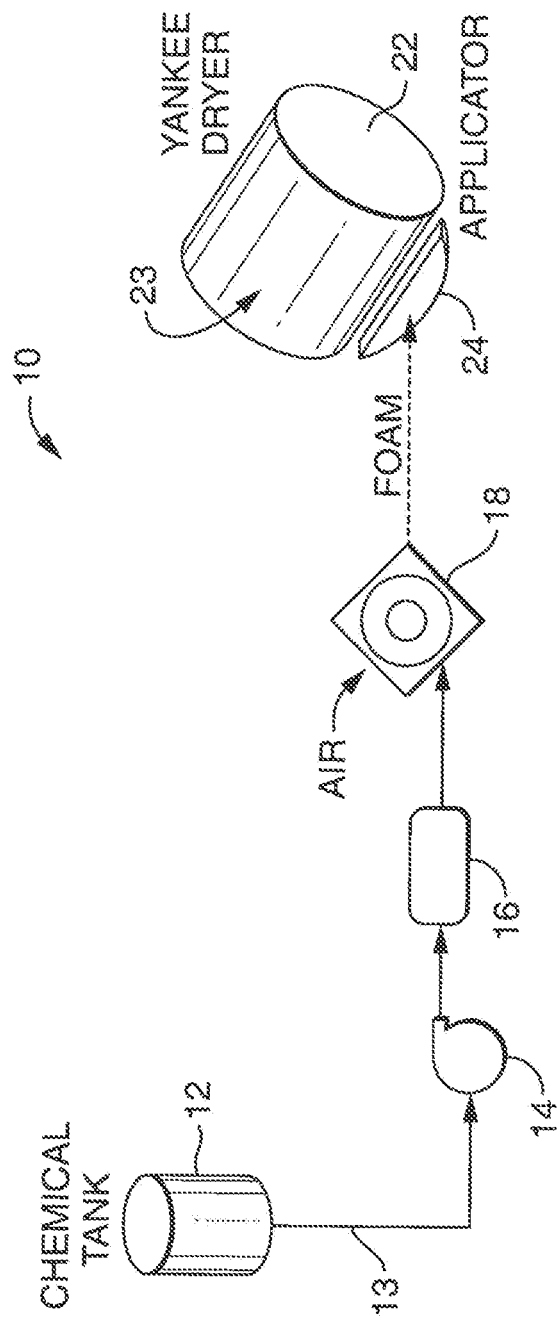


FIG. 1

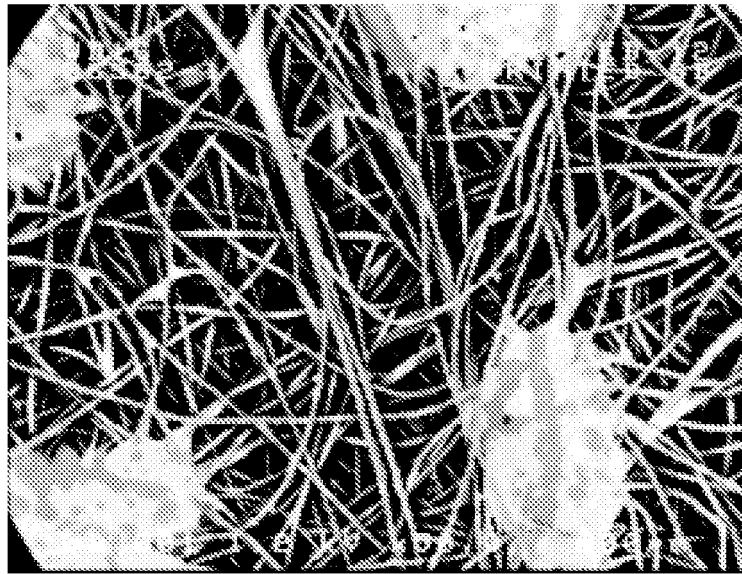


FIG. 2

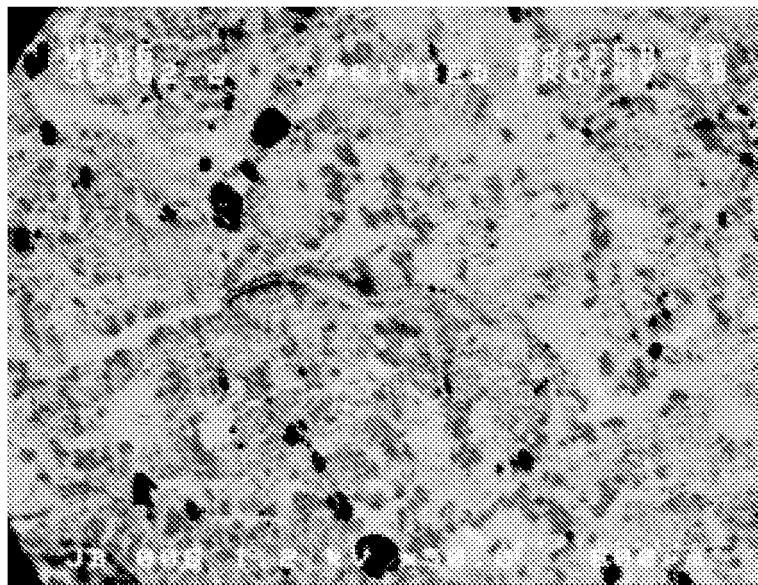


FIG. 3

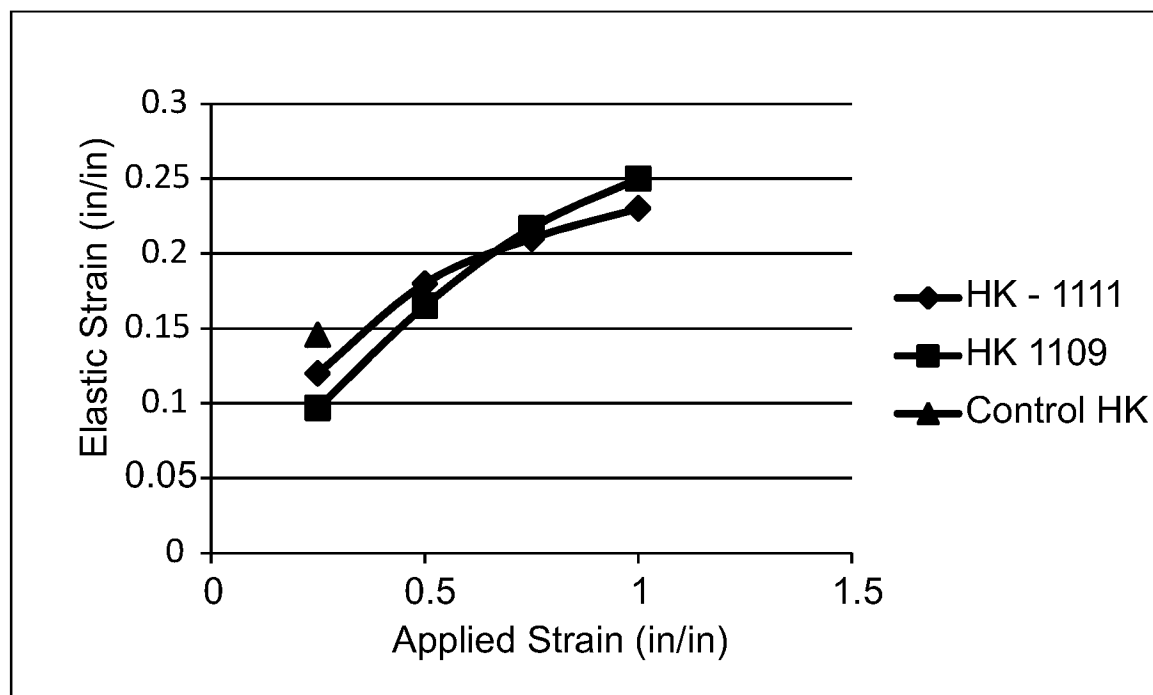


FIG. 4

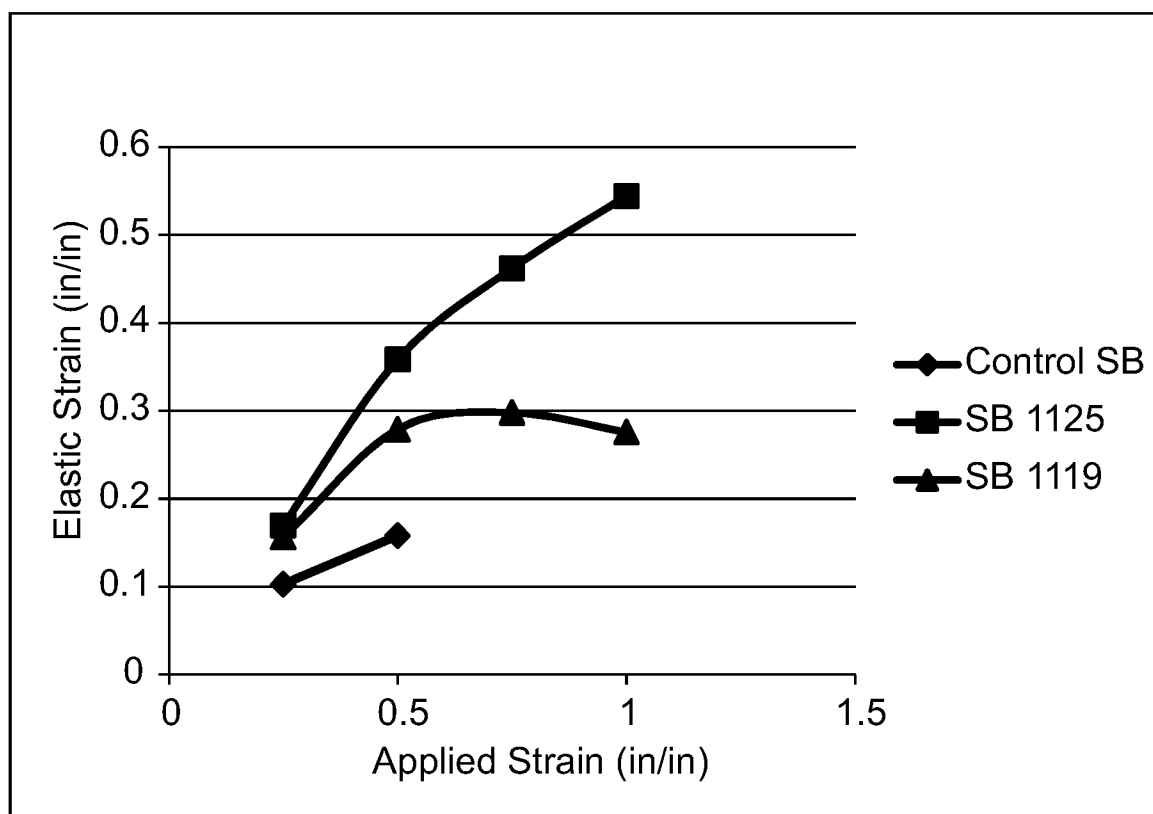


FIG. 5

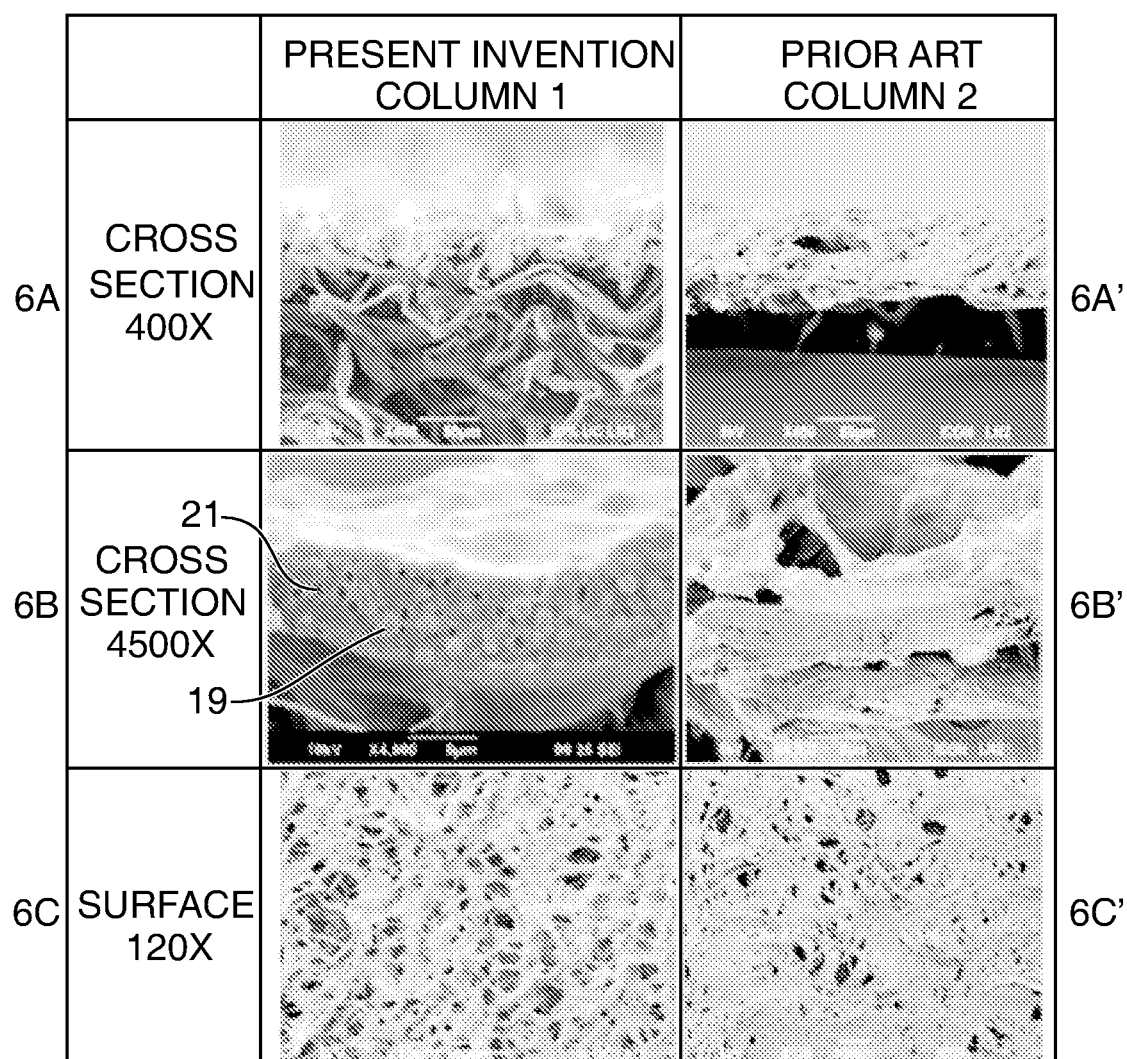


FIG. 6

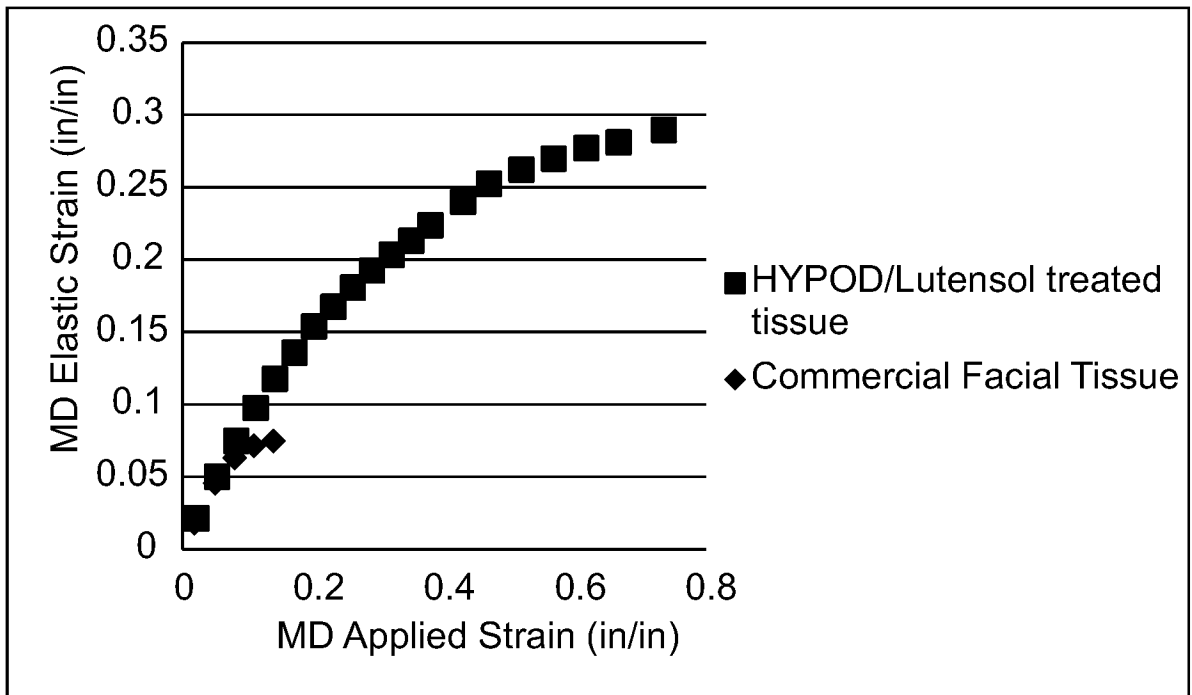


FIG. 7

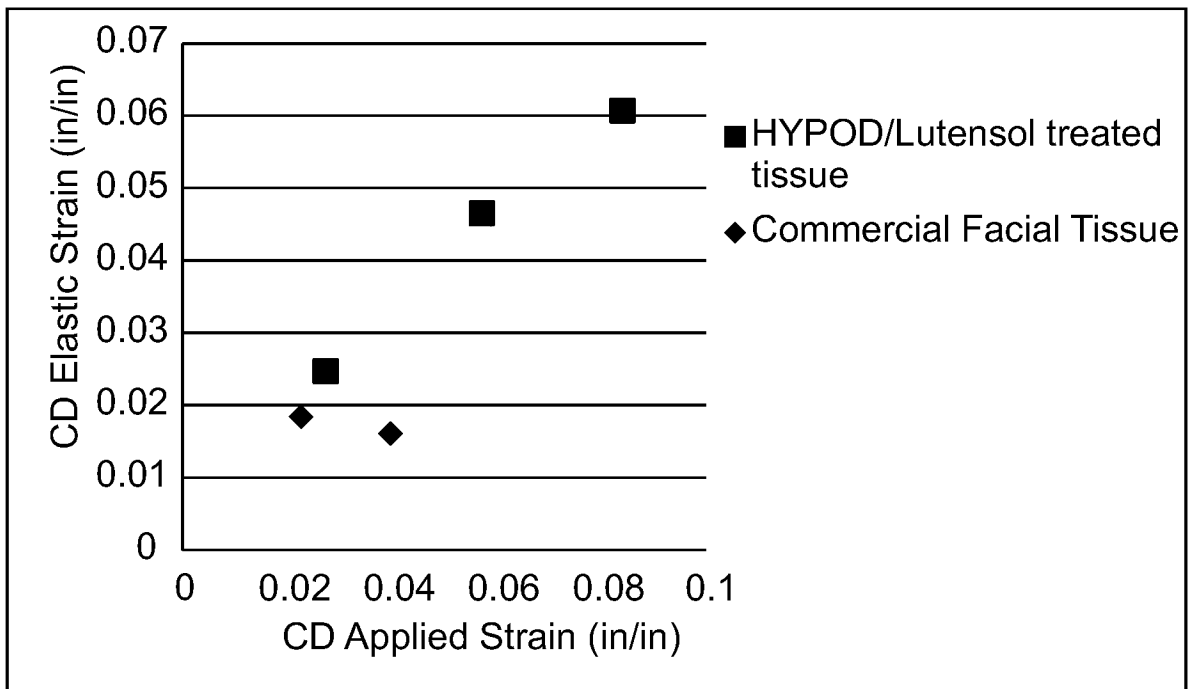


FIG. 8



FIG. 9(a)



FIG. 9(b)

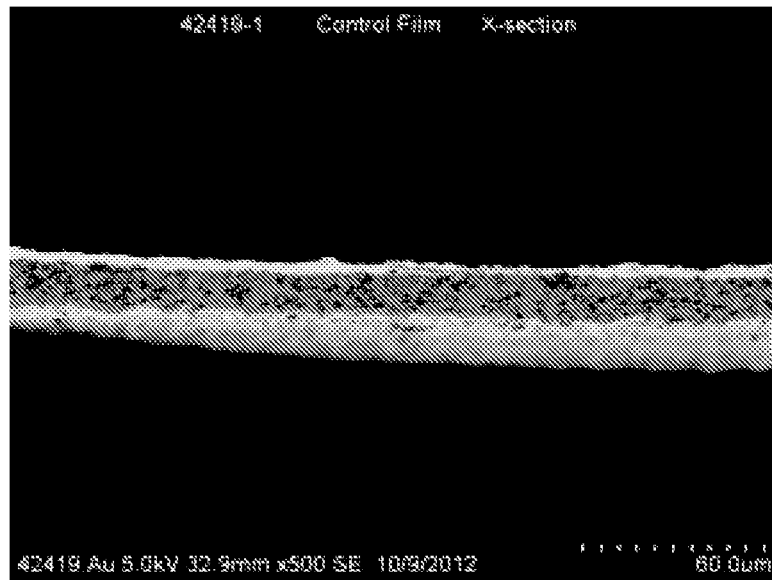


FIG. 9(c)

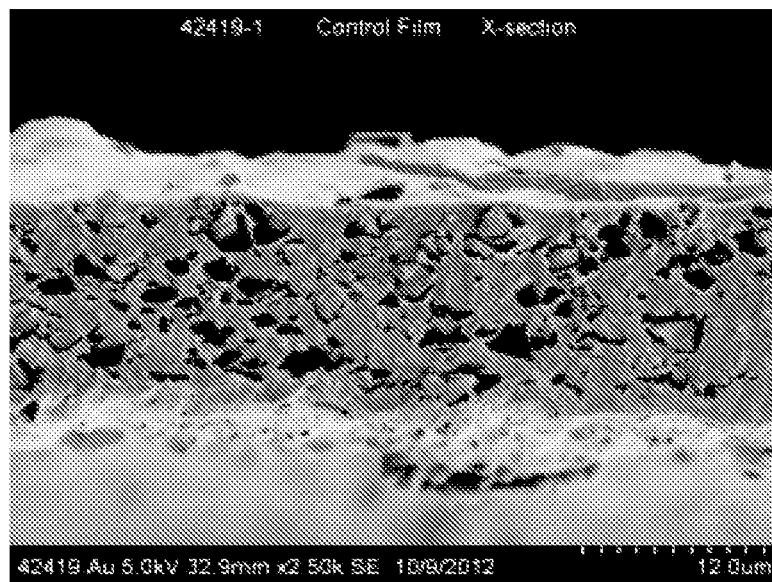


FIG. 9(d)

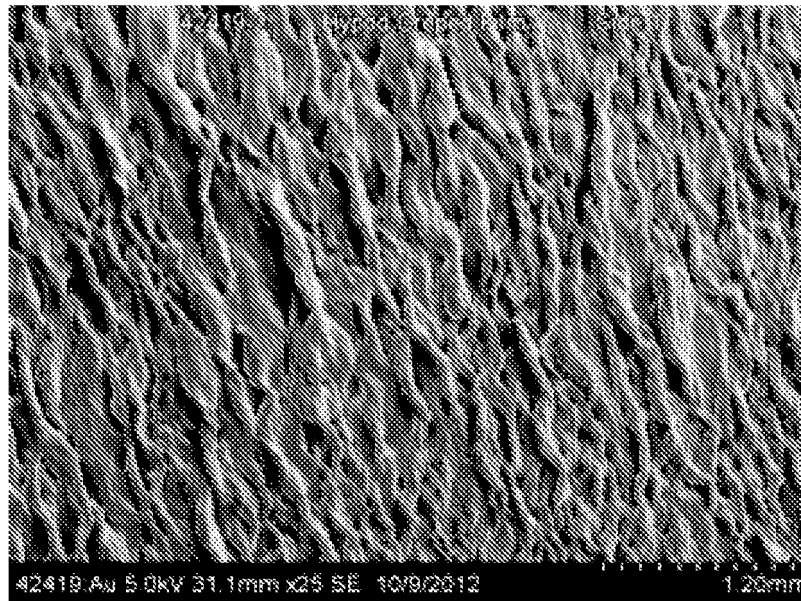


FIG. 10(a)

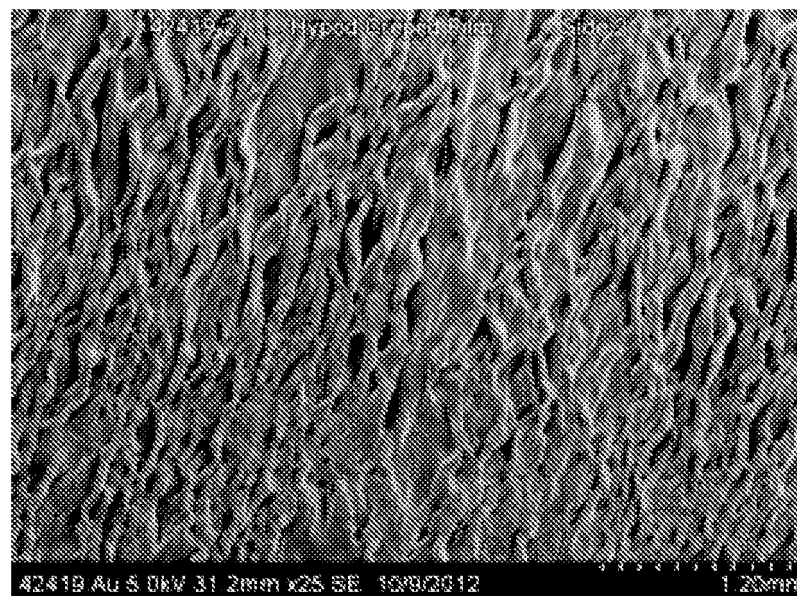


FIG. 10(b)

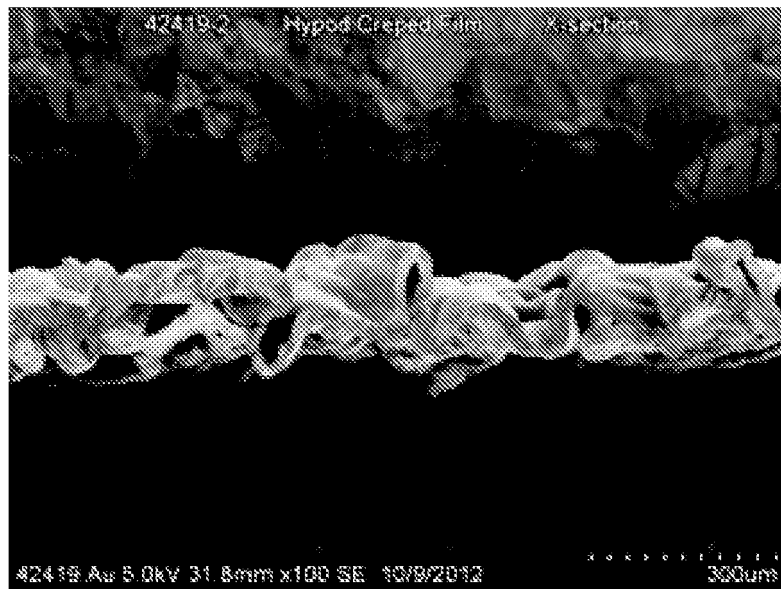


FIG. 10(c)

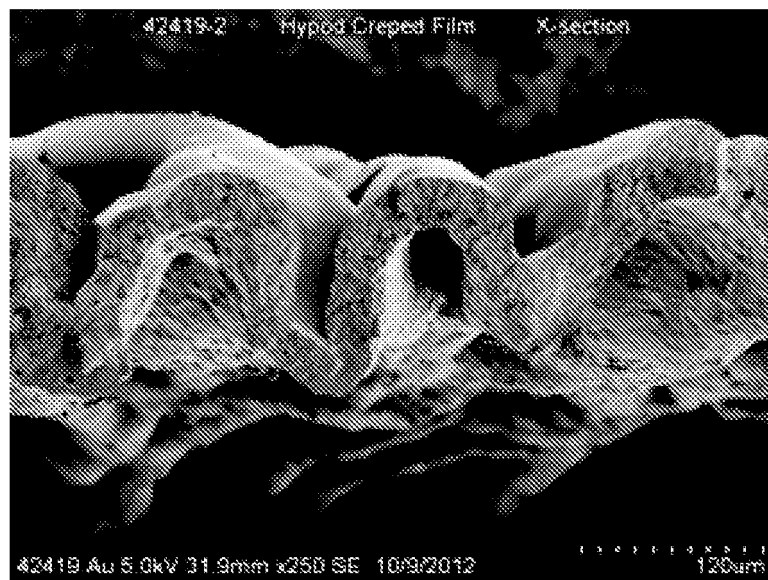


FIG. 10(d)

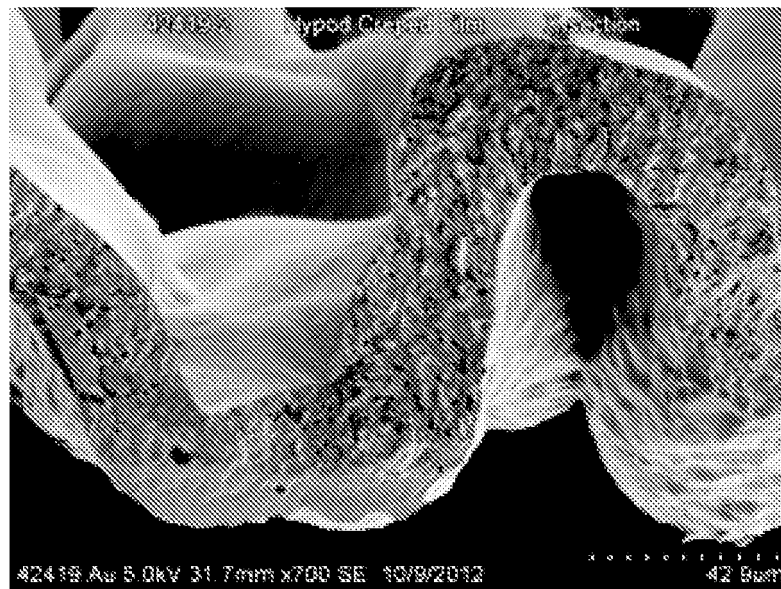


FIG. 10(e)

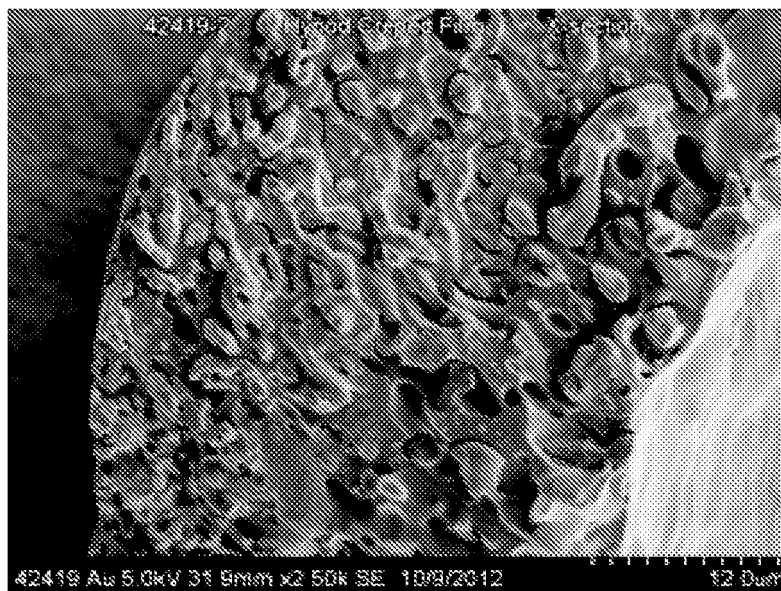


FIG. 10(f)

REFERENCES CITED IN THE DESCRIPTION

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