

PREMOISTENED TISSUE PRODUCTS**BACKGROUND OF THE INVENTION**

Saturated or pre-moistened wiping products have been used in a variety of wiping and polishing applications. Perhaps the most common form is a stack of individual, folded sheets packaged in a plastic container for use as baby wipes.

- 5 Wet wipes are also available containing antimicrobial compositions for cleaning desired surfaces. Wet wipes are typically used only once and then discarded.

Wet wipes designed to clean or disinfect adjacent surfaces are typically made containing synthetic fibers and/or water insoluble adhesives or binders. For instance, many wet wipe materials are made from airlaid webs that have been
10 treated with a water insoluble adhesive or spunlace webs containing water insoluble synthetic fibers. Wet wipe materials may also contain meltspun webs, such as meltblown webs, spunbond webs and laminates thereof. Although these materials have good strength properties, the materials generally are not water dispersible, meaning that the materials do not disintegrate when immersed in
15 water. Thus, the materials are not biodegradable and must be thrown into a trash receptacle after use.

Wetlaid tissue webs have generally not been widely used in order to form saturated or premoistened wiping products. Such webs are typically made predominately from pulp fibers and thus are biodegradable. Such webs, however,
20 typically do not have sufficient wet strength to be used in a premoistened state.

In view of the above, a need currently exists for a presaturated or premoistened wiping product that is more biodegradable than many conventional materials. In particular, a need exists for a premoistened wiping product that can be made from a wetlaid web. Such a product may be less expensive to produce
25 and may feel softer than many of the airlaid webs described above or the polymer webs described above.

SUMMARY OF THE INVENTION

In general, the present disclosure is directed to premoistened wiping products formed from tissue webs that can contain pulp fibers in relatively large
30 amounts. The premoistened wiping product can be a single ply product or can be a multi-ply product. In accordance with the present disclosure, an additive

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composition is contained within the tissue web and the tissue web is then embossed. The additive composition contains a thermoplastic polymer. During embossing, the thermoplastic polymer forms densified areas, such as defined embossments within the tissue web that can not only be aesthetically pleasing but
5 are also liquid resistant. In addition, the additive composition during the embossing process can form bond areas between adjacent webs in a multiple ply product.

Thus, the additive composition provides greater wet strength to the tissue web without significantly interfering with the softness of the web. Of particular
10 advantage, it has also been discovered that the additive composition does not create problems with sheet blocking, which is the tendency of adjacent tissue products to stick together.

As described above, the additive composition may comprise a thermoplastic resin contained within an aqueous dispersion. The additive composition may be
15 added to the tissue product via fiber pre-treatments prior to slurry generation, wet-end addition, and/or topically applied to the web during or after the formation process. In one embodiment, the additive composition is applied topically to the tissue web during a creping operation.

In one embodiment, for instance, the present disclosure is directed to a
20 tissue product comprising a tissue web containing pulp fibers. The tissue web, for instance, may have a dry bulk of at least 3 cc/g. In accordance with the present disclosure, the tissue product further comprises an additive composition present on or in the tissue web. The additive composition may comprise non-fibrous olefin polymers, such as alpha-olefin polymers. Once the tissue web is embossed, the
25 additive composition forms defined embossments in the tissue web. For instance, during embossing, the tissue web may be subjected to heat and/or pressure in an amount sufficient to soften the olefin polymer and form defined embossed areas. The embossments can be visible from one or both sides of the tissue web.

The additive composition, for instance, may comprise a film-forming
30 composition and the olefin polymer may comprise an interpolymer of ethylene and at least one comonomer comprising an alkene, such as 1-octene. The additive composition may also contain a dispersing agent, such as a carboxylic acid.

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Examples of particular dispersing agents, for instance, include fatty acids, such as oleic acid or stearic acid.

In one particular embodiment, the additive composition may contain an ethylene and octene copolymer in combination with an ethylene-acrylic acid
5 copolymer. The ethylene-acrylic acid copolymer is not only a thermoplastic resin, but may also serve as a dispersing agent. The ethylene and octene copolymer may be present in combination with the ethylene-acrylic acid copolymer in a weight ratio of from about 1:10 to about 10:1, such as from about 2:3 to about 3:2.

The polymer composition may exhibit a crystallinity of less than about 50%,
10 such as less than about 20%. The olefin polymer may also have a melt index of less than about 1000 g/10 min, such as less than about 700 g/10 min. The olefin may also have a relatively small particle size, such as from about 0.1 micron to about 5 microns when contained in an aqueous dispersion.

The additive composition may be combined with pulp fibers prior to forming
15 the tissue web. Alternatively or in addition, the additive composition may be topically applied to at least one side of the tissue web. For instance, the additive composition may be sprayed or printed onto the tissue web. In one particular embodiment, the tissue web is creped after application of the additive composition.

The basis weight of the tissue web may vary. For instance, the tissue web
20 may have a basis weight of from about 10 gsm to about 110 gsm, such as from about 15 gsm to about 90 gsm.

In an alternative embodiment, the additive composition may contain an ethylene-carboxylic acid copolymer, such as an ethylene-acrylic acid copolymer, instead of or in combination with the olefin polymer. The ethylene-acrylic acid
25 copolymer may be present in the additive composition in combination with a dispersing agent, such as a fatty acid.

The additive composition may be applied to the tissue web in an amount from about 0.1% to about 50% by weight, such as from about 0.5% to about 10% by weight.

30 Once applied to or incorporated into a tissue web, in accordance with the present disclosure, the tissue web may be embossed by being fed through a nip formed between two embossing rolls or between an embossing roll and a smooth roll. The embossing elements contact the web at a pressure and/or temperature

WO 2007/070153
PCT/US2006/038991
sufficient to soften the thermoplastic polymer and cause the polymer to flow forming defined embossments. Of particular advantage, not only are the embossments well defined and visible but also the additive composition prevents the web from deteriorating in strength during the embossing process.

5 When two or more plies are embossed together, the additive composition not only forms defined embossed areas, but also forms bond areas between the two or more webs.

 The one or more tissue webs may be embossed according to any suitable pattern. For instance, an embossing pattern may be used that comprises a
10 reticulated pattern or, alternatively, the embossing pattern may comprise a pattern of discrete shapes. In one embodiment, two or more tissue webs are embossed together only along the edges of the webs in order to attach the webs together in what is referred to as a crimping process.

 After the tissue sheet is formed and embossed, the tissue sheet is then
15 premoistened with a wiping solution. In general, any suitable wiping solution may be used in accordance with the present disclosure. For instance, in one embodiment, the wiping solution may comprise water in combination with at least one surfactant and/or at least one emollient. In an alternative embodiment, the wiping solution may contain water in combination with an alcohol. Various other
20 and sundry ingredients may be present in the wiping solution such as aloe, a preservative, a glycol, an antimicrobial agent, a fragrance, and the like.

 Other features and aspects of the present invention are discussed in greater detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

25 A full and enabling disclosure of the present invention, including the best mode thereof to one of ordinary skill in the art, is set forth more particularly in the remainder of the specification, including reference to the accompanying figures in which:

 Figure 1 is a schematic diagram of a tissue web forming machine,
30 illustrating the formation of a stratified tissue web having multiple layers in accordance with the present disclosure;

 Figure 2 is a schematic diagram of one embodiment of a process for forming uncreped through-dried tissue webs for use in the present disclosure;

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Figure 3 is a schematic diagram of one embodiment of a process for forming wet creped tissue webs for use in the present disclosure;

Figure 4 is a schematic diagram of one embodiment of a process for applying additive compositions to each side of a tissue web and creping one side of the web in accordance with the present disclosure;

Figure 5 is a plan view of one embodiment of a pattern that is used to apply additive compositions to tissue webs made in accordance with the present disclosure;

Figure 6 is another embodiment of a pattern that is used to apply additive compositions to tissue webs in accordance with the present disclosure;

Figure 7 is a plan view of another alternative embodiment of a pattern that is used to apply additive compositions to tissue webs in accordance with the present disclosure;

Figure 8 is a schematic diagram of an alternative embodiment of a process for applying an additive composition to one side of the tissue web and creping one side of the web in accordance with the present disclosure;

Figure 9 is a side view of one embodiment of a process for embossing a tissue product in accordance with the present disclosure;

Figure 10 is a perspective view of an embossing roller that may be used to emboss tissue webs in accordance with the present disclosure;

Figure 11 is a perspective view of one embodiment of a tissue product made in accordance with the present disclosure; and

Figures 12 and 13 are the results obtained in the Example as described below.

Repeat use of reference characters in the present specification and drawings is intended to represent same or analogous features or elements of the present disclosure.

DETAILED DESCRIPTION

It is to be understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only, and is not intended as limiting the broader aspects of the present disclosure.

In general, the present disclosure is directed to premoistened wiping products that may be used, for instance, as a baby wipe, as a disinfectant wiper,

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as an antimicrobial wiper, and the like. The wiping product is formed from one or more wetlaid tissue webs that contain an additive composition. The additive composition includes a thermoplastic polymer. Once the additive composition is incorporated into the one or more tissue webs, the one or more webs are then embossed.

During an embossing process, the additive composition can be subjected to heat and/or pressure in an amount sufficient to cause the thermoplastic polymer to flow and form densified areas, such as defined embossments. The embossments may also serve as bonding areas for bonding multiple tissue webs together.

Embossing the web may also improve the wet strength and/or the dry strength of the web in addition to various other properties.

After the tissue sheet containing one or more plies is embossed, the tissue sheet is then contacted with a wiping solution. The ingredients of the wiping solution can vary depending upon the use of the final product. For instance, the wiping solution can contain water and an alcohol. Alternatively, the wiping solution may contain water in combination with a surfactant, an emollient, an antimicrobial agent, a fragrance, a preservative, and/or a glycol.

The additive composition may comprise a polyolefin dispersion. For example, the polyolefin dispersion may contain polymeric particles having a relatively small size, such as less than about 5 microns, in an aqueous medium when applied or incorporated into a tissue web. Once dried, however, the polymeric particles are generally indistinguishable. For example, in one embodiment, the additive composition may comprise a film-forming composition that forms a discontinuous but interconnected film. In some embodiments, the polyolefin dispersion may also contain a dispersing agent.

As will be described in greater detail below, the additive composition can be incorporated into a tissue web using various techniques and during different stages of production of the tissue product. For example, in one embodiment, the additive composition can be combined with an aqueous suspension of fibers that is used to form the tissue web. In an alternative embodiment, the additive composition can be applied to a dry pulp sheet that is used to form an aqueous suspension of fibers. In still another embodiment, the additive composition may be topically applied to the tissue web while the tissue web is wet or after the tissue web has

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been dried. For instance, in one embodiment, the additive composition may be applied topically to the tissue web during a creping operation. In particular, the additive composition has been found well-suited for adhering a tissue web to a creping surface during a creping process.

5 The additive composition generally contains an aqueous dispersion comprising at least one thermoplastic resin, water, and, optionally, at least one dispersing agent. The thermoplastic resin is present within the dispersion at a relatively small particle size. For example, the average polymeric particle size of the polymer may be less than about 5 microns. The actual particle size may
10 depend upon various factors including the thermoplastic polymer that is present in the dispersion. Thus, the average volumetric particle size may be from about 0.05 microns to about 5 microns, such as less than about 4 microns, such as less than about 3 microns, such as less than about 2 microns, such as less than about 1 micron. Particle sizes can be measured on a Coulter LS230 light-scattering
15 particle size analyzer or other suitable device. When present in the aqueous dispersion and when present in the tissue web, the thermoplastic resin is typically found in a non-fibrous form.

 The particle size distribution of the polymer particles in the dispersion may be less than or equal to about 2.0, such as less than 1.9, 1.7 or 1.5.

20 Examples of aqueous dispersions that may be incorporated into the additive composition of the present disclosure are disclosed, for instance, in U.S. Patent Application Publication No. 2005/0100754, U.S. Patent Application Publication No. 2005/0192365, PCT Publication No. WO 2005/021638, and PCT Publication No. WO 2005/021622, which are all incorporated herein by reference.

25 The thermoplastic resin contained within the additive composition may vary depending upon the particular application and the desired result. In one embodiment, for instance, thermoplastic resin is an olefin polymer. As used herein, an olefin polymer refers to a class of unsaturated open-chain hydrocarbons having the general formula C_nH_{2n} . The olefin polymer may be present as a
30 copolymer, such as an interpolymer. As used herein, a substantially olefin polymer refers to a polymer that contains less than about 1% substitution.

 In one particular embodiment, for instance, the olefin polymer may comprise an alpha-olefin interpolymer of ethylene with at least one comonomer selected

from the group consisting of a C₄-C₂₀ linear, branched or cyclic diene, or an ethylene vinyl compound, such as vinyl acetate, and a compound represented by the formula H₂C=CHR wherein R is a C₁-C₂₀ linear, branched or cyclic alkyl group or a C₆-C₂₀ aryl group. Examples of comonomers include propylene, 1-butene, 3-methyl-1-butene, 4-methyl-1-pentene, 3-methyl-1-pentene, 1-heptene, 1-hexene, 1-octene, 1-decene, and 1-dodecene. In some embodiments, the interpolymer of ethylene has a density of less than about 0.92 g/cc.

In other embodiments, the thermoplastic resin comprises an alpha-olefin interpolymer of propylene with at least one comonomer selected from the group consisting of ethylene, a C₄-C₂₀ linear, branched or cyclic diene, and a compound represented by the formula H₂C=CHR wherein R is a C₁-C₂₀ linear, branched or cyclic alkyl group or a C₆-C₂₀ aryl group. Examples of comonomers include ethylene, 1-butene, 3-methyl-1-butene, 4-methyl-1-pentene, 3-methyl-1-pentene, 1-heptene, 1-hexene, 1-octene, 1-decene, and 1-dodecene. In some embodiments, the comonomer is present at about 5% by weight to about 25% by weight of the interpolymer. In one embodiment, a propylene-ethylene interpolymer is used.

Other examples of thermoplastic resins which may be used in the present disclosure include homopolymers and copolymers (including elastomers) of an olefin such as ethylene, propylene, 1-butene, 3-methyl-1-butene, 4-methyl-1-pentene, 3-methyl-1-pentene, 1-heptene, 1-hexene, 1-octene, 1-decene, and 1-dodecene as typically represented by polyethylene, polypropylene, poly-1-butene, poly-3-methyl-1-butene, poly-3-methyl-1-pentene, poly-4-methyl-1-pentene, ethylene-propylene copolymer, ethylene-1-butene copolymer, and propylene-1-butene copolymer; copolymers (including elastomers) of an alpha-olefin with a conjugated or non-conjugated diene as typically represented by ethylene-butadiene copolymer and ethylene-ethylidene norbornene copolymer; and polyolefins (including elastomers) such as copolymers of two or more alpha-olefins with a conjugated or non-conjugated diene as typically represented by ethylene-propylene-butadiene copolymer, ethylene-propylene-dicyclopentadiene copolymer, ethylene-propylene-1,5-hexadiene copolymer, and ethylene-propylene-ethylidene norbornene copolymer; ethylene-vinyl compound copolymers such as ethylene-vinyl acetate copolymers with N-methylol functional comonomers,

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ethylene-vinyl alcohol copolymers with N-methylol functional comonomers, ethylene-vinyl chloride copolymer, ethylene acrylic acid or ethylene-(meth)acrylic acid copolymers, and ethylene-(meth)acrylate copolymer; styrenic copolymers (including elastomers) such as polystyrene, ABS, acrylonitrile-styrene copolymer, 5 methylstyrene-styrene copolymer; and styrene block copolymers (including elastomers) such as styrene-butadiene copolymer and hydrate thereof, and styrene-isoprene-styrene triblock copolymer; polyvinyl compounds such as polyvinyl chloride, polyvinylidene chloride, vinyl chloride-vinylidene chloride copolymer, polymethyl acrylate, and polymethyl methacrylate; polyamides such as 10 nylon 6, nylon 6,6, and nylon 12; thermoplastic polyesters such as polyethylene terephthalate and polybutylene terephthalate; polycarbonate, polyphenylene oxide, and the like. These resins may be used either alone or in combinations of two or more.

In particular embodiments, polyolefins such as polypropylene, polyethylene, 15 and copolymers thereof and blends thereof, as well as ethylene-propylene-diene terpolymers are used. In some embodiments, the olefinic polymers include homogeneous polymers described in U.S. Pat. No. 3,645,992 by Elston; high density polyethylene (HDPE) as described in U.S. Pat. No. 4,076,698 to Anderson; heterogeneously branched linear low density polyethylene (LLDPE); 20 heterogeneously branched ultra low linear density (ULDPE); homogeneously branched, linear ethylene/alpha-olefin copolymers; homogeneously branched, substantially linear ethylene/alpha-olefin polymers which can be prepared, for example, by a process disclosed in U.S. Pat. Nos. 5,272,236 and 5,278,272, the disclosure of which process is incorporated herein by reference; and high 25 pressure, free radical polymerized ethylene polymers and copolymers such as low density polyethylene (LDPE).

In still another embodiment of the present invention, the thermoplastic resin comprises an ethylene-carboxylic acid copolymer, such as, ethylene-acrylic acid (EAA) and ethylene-methacrylic acid copolymers such as for example those 30 available under the tradenames PRIMACORTM from the Dow Chemical Company, NucrelTM from DuPont, and EscorTM from ExxonMobil and described in U.S. Pat. Nos. 4,599,392, 4,988,781, and 5,384,373, each of which is incorporated herein by reference in its entirety, and ethylene-vinyl acetate (EVA) copolymers. Polymer

PCT/US2006/038991

compositions described in U.S. Pat. Nos. 6,538,070, 6,566,446, 5,869,575, 6,448,341, 5,677,383, 6,316,549, 6,111,023, or 5,844,045, each of which is incorporated herein by reference in its entirety, are also suitable in some embodiments. Of course, blends of polymers can be used as well. In some
5 embodiments, the blends include two different Ziegler-Natta polymers. In other embodiments, the blends can include blends of a Ziegler-Natta and a metallocene polymer. In still other embodiments, the thermoplastic resin used herein is a blend of two different metallocene polymers.

 In one particular embodiment, the thermoplastic resin comprises an alpha-
10 olefin interpolymer of ethylene with a comonomer comprising an alkene, such as 1-octene. The ethylene and octene copolymer may be present alone in the additive composition or in combination with another thermoplastic resin, such as ethylene-acrylic acid copolymer. Of particular advantage, the ethylene-acrylic acid copolymer not only is a thermoplastic resin, but also serves as a dispersing agent.
15 For some embodiments, the additive composition should comprise a film-forming composition. It has been found that the ethylene-acrylic acid copolymer may assist in forming films, while the ethylene and octene copolymer lowers the stiffness. When applied to a tissue web, the composition may or may not form a film within the product, depending upon how the composition is applied and the
20 amount of the composition that is applied. When forming a film on the tissue web, the film may be continuous or discontinuous. When present together, the weight ratio between the ethylene and octene copolymer and the ethylene-acrylic acid copolymer may be from about 1:10 to about 10:1, such as from about 3:2 to about 2:3.

25 The thermoplastic resin, such as the ethylene and octene copolymer, may have a crystallinity of less than about 50%, such as less than about 25%. The polymer may have been produced using a single site catalyst and may have a weight average molecular weight of from about 15,000 to about 5 million, such as from about 20,000 to about 1 million. The molecular weight distribution of the
30 polymer may be from about 1.01 to about 40, such as from about 1.5 to about 20, such as from about 1.8 to about 10.

 Depending upon the thermoplastic polymer, the melt index of the polymer may range from about 0.001 g/10 min to about 1,000 g/10 min, such as from about

PCT/US2006/038991

0.5 g/10 min to about 800 g/10 min. For example, in one embodiment, the melt index of the thermoplastic resin may be from about 100 g/10 min to about 700 g/10 min.

The thermoplastic resin may also have a relatively low melting point. For instance, the melting point of the thermoplastic resin may be less than about 140°C, such as less than 130°C, such as less than 120°C. For instance, in one embodiment, the melting point may be less than about 90°C. The glass transition temperature of the thermoplastic resin may also be relatively low. For instance, the glass transition temperature may be less than about 50°C, such as less than about 40°C.

The one or more thermoplastic resins may be contained within the additive composition in an amount from about 1% by weight to about 96% by weight. For instance, the thermoplastic resin may be present in the aqueous dispersion in an amount from about 10% by weight to about 70% by weight, such as from about 20% to about 50% by weight.

In addition to at least one thermoplastic resin, the aqueous dispersion may also contain a dispersing agent. A dispersing agent is an agent that aids in the formation and/or the stabilization of the dispersion. One or more dispersing agents may be incorporated into the additive composition.

In general, any suitable dispersing agent can be used. In one embodiment, for instance, the dispersing agent comprises at least one carboxylic acid, a salt of at least one carboxylic acid, or carboxylic acid ester or salt of the carboxylic acid ester. Examples of carboxylic acids useful as a dispersant comprise fatty acids such as montanic acid, stearic acid, oleic acid, and the like. In some embodiments, the carboxylic acid, the salt of the carboxylic acid, or at least one carboxylic acid fragment of the carboxylic acid ester or at least one carboxylic acid fragment of the salt of the carboxylic acid ester has fewer than 25 carbon atoms. In other embodiments, the carboxylic acid, the salt of the carboxylic acid, or at least one carboxylic acid fragment of the carboxylic acid ester or at least one carboxylic acid fragment of the salt of the carboxylic acid ester has 12 to 25 carbon atoms. In some embodiments, carboxylic acids, salts of the carboxylic acid, at least one carboxylic acid fragment of the carboxylic acid ester or its salt has 15 to 25 carbon atoms are preferred. In other embodiments, the number of carbon

atoms is 25 to 60. Some examples of salts comprise a cation selected from the group consisting of an alkali metal cation, alkaline earth metal cation, or ammonium or alkyl ammonium cation.

In still other embodiments, the dispersing agent is selected from the group consisting of ethylene-carboxylic acid polymers, and their salts, such as ethylene-acrylic acid copolymers or ethylene-methacrylic acid copolymers.

In other embodiments, the dispersing agent is selected from alkyl ether carboxylates, petroleum sulfonates, sulfonated polyoxyethylenated alcohol, sulfated or phosphated polyoxyethylenated alcohols, polymeric ethylene oxide/propylene oxide/ethylene oxide dispersing agents, primary and secondary alcohol ethoxylates, alkyl glycosides and alkyl glycerides.

When ethylene-acrylic acid copolymer is used as a dispersing agent, the copolymer may also serve as a thermoplastic resin.

In one particular embodiment, the aqueous dispersion contains an ethylene and octene copolymer, ethylene-acrylic acid copolymer, and a fatty acid, such as stearic acid or oleic acid. The dispersing agent, such as the carboxylic acid, may be present in the aqueous dispersion in an amount from about 0.1% to about 10% by weight.

In addition to the above components, the aqueous dispersion also contains water. Water may be added as deionized water, if desired. The pH of the aqueous dispersion is generally less than about 12, such as from about 5 to about 11.5, such as from about 7 to about 11. The aqueous dispersion may have a solids content of less than about 75%, such as less than about 70%. For instance, the solids content of the aqueous dispersion may range from about 5% to about 60%. In general, the solids content can be varied depending upon the manner in which the additive composition is applied or incorporated into the tissue web. For instance, when incorporated into the tissue web during formation, such as by being added with an aqueous suspension of fibers, a relatively high solids content can be used. When topically applied such as by spraying or printing, however, a lower solids content may be used in order to improve processability through the spray or printing device.

While any method may be used to produce the aqueous dispersion, in one embodiment, the dispersion may be formed through a melt-kneading process. For

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example, the kneader may comprise a Banbury mixer, single-screw extruder or a multi-screw extruder. The melt-kneading may be conducted under the conditions which are typically used for melt-kneading the one or more thermoplastic resins.

5 In one particular embodiment, the process includes melt-kneading the components that make up the dispersion. The melt-kneading machine may include multiple inlets for the various components. For example, the extruder may include four inlets placed in series. Further, if desired, a vacuum vent may be added at an optional position of the extruder.

10 In some embodiments, the dispersion is first diluted to contain about 1 to about 3% by weight water and then, subsequently, further diluted to comprise greater than about 25% by weight water.

When treating tissue webs in accordance with the present disclosure, the additive composition containing the aqueous polymer dispersion can be applied to the tissue web topically or can be incorporated into the tissue web by being pre-
15 mixed with the fibers that are used to form the web. When applied topically, the additive composition can be applied to the tissue web when wet or dry. In one embodiment, the additive composition may be applied topically to the web during a creping process. For instance, in one embodiment, the additive composition may be sprayed onto the web or onto a heated dryer drum in order to adhere the web to
20 the dryer drum. The web can then be creped from the dryer drum. When the additive composition is applied to the web and then adhered to the dryer drum, the composition may be uniformly applied over the surface area of the web or may be applied according to a particular pattern.

When topically applied to a tissue web, the additive composition may be
25 sprayed onto the web, extruded onto the web, or printed onto the web. When extruded onto the web, any suitable extrusion device may be used, such as a slot-coat extruder or a meltblown dye extruder. When printed onto the web, any suitable printing device may be used. For example, an inkjet printer or a rotogravure printing device may be used.

30 In one embodiment, the additive composition may be heated prior to or during application to a tissue web. Heating the composition can lower the viscosity for facilitating application. For instance, the additive composition may be heated to a temperature of from about 50°C to about 150°C.

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Tissue products made according to the present disclosure may include single-ply tissue products or multiple-ply tissue products. For instance, in one embodiment, the product may include two plies or three plies.

In general, any suitable tissue web may be treated in accordance with the present disclosure. For example, in one embodiment, the base sheet can be a tissue product, such as a bath tissue, a facial tissue, a paper towel, an industrial wiper, and the like. Tissue products typically have a bulk density of at least 3 cc/g. The tissue products can contain one or more plies and can be made from any suitable types of fiber.

Fibers suitable for making tissue webs comprise any natural or synthetic cellulosic fibers including, but not limited to nonwoody fibers, such as cotton, abaca, kenaf, sabai grass, flax, esparto grass, straw, jute hemp, bagasse, milkweed floss fibers, and pineapple leaf fibers; and woody or pulp fibers such as those obtained from deciduous and coniferous trees, including softwood fibers, such as northern and southern softwood kraft fibers; hardwood fibers, such as eucalyptus, maple, birch, and aspen. Pulp fibers can be prepared in high-yield or low-yield forms and can be pulped in any known method, including kraft, sulfite, high-yield pulping methods and other known pulping methods. Fibers prepared from organosolv pulping methods can also be used, including the fibers and methods disclosed in U.S. Patent No. 4,793,898, issued Dec. 27, 1988 to Laamanen et al.; U.S. Patent No. 4,594,130, issued June 10, 1986 to Chang et al.; and U.S. Patent No. 3,585,104. Useful fibers can also be produced by anthraquinone pulping, exemplified by U.S. Patent No. 5,595,628 issued Jan. 21, 1997, to Gordon et al.

A portion of the fibers, such as up to 50% or less by dry weight, or from about 5% to about 30% by dry weight, can be synthetic fibers such as rayon, polyolefin fibers, polyester fibers, bicomponent sheath-core fibers, multi-component binder fibers, and the like. An exemplary polyethylene fiber is Pulpex®, available from Hercules, Inc. (Wilmington, DE). Any known bleaching method can be used. Synthetic cellulose fiber types include rayon in all its varieties and other fibers derived from viscose or chemically-modified cellulose.

Chemically treated natural cellulosic fibers can be used such as mercerized pulps, chemically stiffened or crosslinked fibers, or sulfonated fibers. For good

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mechanical properties in using papermaking fibers, it can be desirable that the fibers be relatively undamaged and largely unrefined or only lightly refined. While recycled fibers can be used, virgin fibers are generally useful for their mechanical properties and lack of contaminants. Mercerized fibers, regenerated cellulosic
5 fibers, cellulose produced by microbes, rayon, and other cellulosic material or cellulosic derivatives can be used. Suitable papermaking fibers can also include recycled fibers, virgin fibers, or mixes thereof. In certain embodiments capable of high bulk and good compressive properties, the fibers can have a Canadian
Standard Freeness of at least 200, more specifically at least 300, more specifically
10 still at least 400, and most specifically at least 500.

Other papermaking fibers that can be used in the present disclosure include paper broke or recycled fibers and high yield fibers. High yield pulp fibers are those papermaking fibers produced by pulping processes providing a yield of about 65% or greater, more specifically about 75% or greater, and still more
15 specifically about 75% to about 95%. Yield is the resulting amount of processed fibers expressed as a percentage of the initial wood mass. Such pulping processes include bleached chemithermomechanical pulp (BCTMP), chemithermomechanical pulp (CTMP), pressure/pressure thermomechanical pulp (PTMP), thermomechanical pulp (TMP), thermomechanical chemical pulp (TMCP),
20 high yield sulfite pulps, and high yield Kraft pulps, all of which leave the resulting fibers with high levels of lignin. High yield fibers are well known for their stiffness in both dry and wet states relative to typical chemically pulped fibers.

In general, any process capable of forming a paper web can also be utilized in the present disclosure. For example, a papermaking process of the present
25 disclosure can utilize creping, wet creping, double creping, embossing, wet pressing, air pressing, through-air drying, creped through-air drying, uncreped through-air drying, hydroentangling, air laying, as well as other steps known in the art. The tissue web may be formed from a fiber furnish containing pulp fibers in an amount of at least 50% by weight, such as at least 60% by weight, such as at least
30 70% by weight, such as at least 80% by weight, such as at least 90% by weight, such as 100% by weight.

Also suitable for products of the present disclosure are tissue sheets that are pattern densified or imprinted, such as the tissue sheets disclosed in any of the

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following U.S. Patent Nos.: 4,514,345 issued on April 30, 1985, to Johnson et al.; 4,528,239 issued on July 9, 1985, to Trokhan; 5,098,522 issued on March 24, 1992; 5,260,171 issued on November 9, 1993, to Smurkoski et al.; 5,275,700 issued on January 4, 1994, to Trokhan; 5,328,565 issued on July 12, 1994, to
5 Rasch et al.; 5,334,289 issued on August 2, 1994, to Trokhan et al.; 5,431,786 issued on July 11, 1995, to Rasch et al.; 5,496,624 issued on March 5, 1996, to Steltjes, Jr. et al.; 5,500,277 issued on March 19, 1996, to Trokhan et al.; 5,514,523 issued on May 7, 1996, to Trokhan et al.; 5,554,467 issued on September 10, 1996, to Trokhan et al.; 5,566,724 issued on October 22, 1996, to
10 Trokhan et al.; 5,624,790 issued on April 29, 1997, to Trokhan et al.; and, 5,628,876 issued on May 13, 1997, to Ayers et al., the disclosures of which are incorporated herein by reference to the extent that they are non-contradictory herewith. Such imprinted tissue sheets may have a network of densified regions that have been imprinted against a drum dryer by an imprinting fabric, and regions
15 that are relatively less densified (e.g., "domes" in the tissue sheet) corresponding to deflection conduits in the imprinting fabric, wherein the tissue sheet superposed over the deflection conduits was deflected by an air pressure differential across the deflection conduit to form a lower-density pillow-like region or dome in the tissue sheet.

20 The tissue web can also be formed without a substantial amount of inner fiber-to-fiber bond strength. In this regard, the fiber furnish used to form the base web can be treated with a chemical debonding agent. The debonding agent can be added to the fiber slurry during the pulping process or can be added directly to the headbox. Suitable debonding agents that may be used in the present
25 disclosure include cationic debonding agents such as fatty dialkyl quaternary amine salts, mono fatty alkyl tertiary amine salts, primary amine salts, imidazoline quaternary salts, silicone quaternary salt and unsaturated fatty alkyl amine salts. Other suitable debonding agents are disclosed in U.S. Patent No. 5,529,665 to Kaun which is incorporated herein by reference. In particular, Kaun discloses the
30 use of cationic silicone compositions as debonding agents.

In one embodiment, the debonding agent used in the process of the present disclosure is an organic quaternary ammonium chloride and, particularly, a silicone-based amine salt of a quaternary ammonium chloride. For example, the

~~PCT/US2006/038991~~

debonding agent can be PROSOFT® TQ1003, marketed by the Hercules

Corporation. The debonding agent can be added to the fiber slurry in an amount of from about 1 kg per metric tonne to about 10 kg per metric tonne of fibers present within the slurry.

- 5 In an alternative embodiment, the debonding agent can be an imidazoline-based agent. The imidazoline-based debonding agent can be obtained, for instance, from the Witco Corporation. The imidazoline-based debonding agent can be added in an amount of between 2.0 to about 15 kg per metric tonne.

10 In one embodiment, the debonding agent can be added to the fiber furnish according to a process as disclosed in PCT Application having an International Publication No. WO 99/34057 filed on December 17, 1998 or in PCT Published Application having an International Publication No. WO 00/66835 filed on April 28, 2000, which are both incorporated herein by reference. In the above publications, a process is disclosed in which a chemical additive, such as a debonding agent, is
15 adsorbed onto cellulosic papermaking fibers at high levels. The process includes the steps of treating a fiber slurry with an excess of the chemical additive, allowing sufficient residence time for adsorption to occur, filtering the slurry to remove unadsorbed chemical additives, and redispersing the filtered pulp with fresh water prior to forming a nonwoven web.

20 Wet and dry strength agents may also be applied to the tissue sheet. As used herein, "wet strength agents" refer to materials used to immobilize the bonds between fibers in the wet state. Typically, the means by which fibers are held together in paper and tissue products involve hydrogen bonds and sometimes combinations of hydrogen bonds and covalent and/or ionic bonds. In the present
25 invention, it may be useful to provide a material that will allow bonding of fibers in such a way as to immobilize the fiber-to-fiber bond points and make them resistant to disruption in the wet state.

 Any material that when added to a tissue sheet or sheet results in providing the tissue sheet with a mean wet geometric tensile strength:dry geometric tensile
30 strength ratio in excess of about 0.1 will, for purposes of the present invention, be termed a wet strength agent. Typically these materials are termed either as permanent wet strength agents or as "temporary" wet strength agents. For the purposes of differentiating permanent wet strength agents from temporary wet

~~PCT/US2006/038991~~

strength agents, the permanent wet strength agents will be defined as those resins which, when incorporated into paper or tissue products, will provide a paper or tissue product that retains more than 50% of its original wet strength after exposure to water for a period of at least five minutes. Temporary wet strength agents are those which show about 50% or less than, of their original wet strength after being saturated with water for five minutes. Both classes of wet strength agents find application in the present invention. The amount of wet strength agent added to the pulp fibers may be at least about 0.1 dry weight percent, more specifically about 0.2 dry weight percent or greater, and still more specifically from about 0.1 to about 3 dry weight percent, based on the dry weight of the fibers.

Permanent wet strength agents will typically provide a more or less long-term wet resilience to the structure of a tissue sheet. In contrast, the temporary wet strength agents will typically provide tissue sheet structures that had low density and high resilience, but would not provide a structure that had long-term resistance to exposure to water or body fluids.

The temporary wet strength agents may be cationic, nonionic or anionic. Such compounds include PAREZ™ 631 NC and PAREZ® 725 temporary wet strength resins that are cationic glyoxylated polyacrylamide available from Cytec Industries (West Paterson, New Jersey). This and similar resins are described in U.S. Patent No. 3,556,932, issued on January 19, 1971, to Coscia et al. and U.S. Patent No. 3,556,933, issued on January 19, 1971, to Williams et al. Hercobond 1366, manufactured by Hercules, Inc., located at Wilmington, Delaware, is another commercially available cationic glyoxylated polyacrylamide that may be used in accordance with the present invention. Additional examples of temporary wet strength agents include dialdehyde starches such as Cobond® 1000 from National Starch and Chemical Company and other aldehyde containing polymers such as those described in U.S. Patent No. 6,224,714, issued on May 1, 2001, to Schroeder et al.; U.S. Patent No. 6,274,667, issued on August 14, 2001, to Shannon et al.; U.S. Patent No. 6,287,418, issued on September 11, 2001, to Schroeder et al.; and, U.S. Patent No. 6,365,667, issued on April 2, 2002, to Shannon et al., the disclosures of which are herein incorporated by reference to the extent they are non-contradictory herewith.

~~PCT/US06/38991~~

Permanent wet strength agents comprising cationic oligomeric or polymeric resins can be used in the present invention. Polyamide-polyamine-epichlorohydrin type resins such as KYMENE 557H sold by Hercules, Inc., located at Wilmington, Delaware, are the most widely used permanent wet-strength agents and are

5 suitable for use in the present invention. Such materials have been described in the following U.S. Patent Nos.: 3,700,623, issued on October 24, 1972, to Keim; 3,772,076, issued on November 13, 1973, to Keim; 3,855,158, issued on December 17, 1974, to Petrovich et al.; 3,899,388, issued on August 12, 1975, to Petrovich et al.; 4,129,528, issued on December 12, 1978, to Petrovich et al.;

10 4,147,586, issued on April 3, 1979, to Petrovich et al.; and, 4,222,921, issued on September 16, 1980, to van Eenam. Other cationic resins include polyethylenimine resins and aminoplast resins obtained by reaction of formaldehyde with melamine or urea. It can be advantageous to use both permanent and temporary wet strength resins in the manufacture of tissue

15 products.

Dry strength agents are well known in the art and include but are not limited to modified starches and other polysaccharides such as cationic, amphoteric, and anionic starches and guar and locust bean gums, modified polyacrylamides, carboxymethylcellulose, sugars, polyvinyl alcohol, chitosans, and the like. Such

20 dry strength agents are typically added to a fiber slurry prior to tissue sheet formation or as part of the creping package.

Optional chemical additives may also be added to the aqueous papermaking furnish or to the formed embryonic web to impart additional benefits to the product and process and are not antagonistic to the intended benefits of the

25 invention. The following materials are included as examples of additional chemicals that may be applied to the web along with the additive composition of the present invention. The chemicals are included as examples and are not intended to limit the scope of the invention. Such chemicals may be added at any point in the papermaking process, including being added simultaneously with the

30 additive composition in the pulp making process, wherein said additive or additives are blended directly with the additive composition.

~~PCT/US06/38991~~

Additional types of chemicals that may be added to the paper web include, but is not limited to, absorbency aids usually in the form of cationic, anionic, or non-ionic surfactants, humectants and plasticizers such as low molecular weight polyethylene glycols and polyhydroxy compounds such as glycerin and propylene glycol. Materials that supply skin health benefits such as mineral oil, aloe extract, vitamin e, silicone, lotions in general and the like may also be incorporated into the finished products.

In general, the products of the present invention can be used in conjunction with any known materials and chemicals that are not antagonistic to its intended use. Examples of such materials include but are not limited to odor control agents, such as odor absorbents, activated carbon fibers and particles, baby powder, baking soda, chelating agents, zeolites, perfumes or other odor-masking agents, cyclodextrin compounds, oxidizers, and the like. Superabsorbent particles, synthetic fibers, or films may also be employed. Additional options include cationic dyes, optical brighteners, humectants, emollients, and the like.

Tissue webs that may be treated in accordance with the present disclosure may include a single homogenous layer of fibers or may include a stratified or layered construction. For instance, the tissue web ply may include two or three layers of fibers. Each layer may have a different fiber composition. For example, referring to **Fig. 1**, one embodiment of a device for forming a multi-layered stratified pulp furnish is illustrated. As shown, a three-layered headbox **10** generally includes an upper head box wall **12** and a lower head box wall **14**. Headbox **10** further includes a first divider **16** and a second divider **18**, which separate three fiber stock layers.

Each of the fiber layers comprise a dilute aqueous suspension of papermaking fibers. The particular fibers contained in each layer generally depends upon the product being formed and the desired results. For instance, the fiber composition of each layer may vary depending upon whether a bath tissue product, facial tissue product or paper towel is being produced. In one embodiment, for instance, middle layer **20** contains southern softwood kraft fibers either alone or in combination with other fibers such as high yield fibers. Outer layers **22** and **24**, on the other hand, contain softwood fibers, such as northern softwood kraft.

PCT/US2006/038991

In an alternative embodiment, the middle layer may contain softwood fibers for strength, while the outer layers may comprise hardwood fibers, such as eucalyptus fibers, for a perceived softness.

An endless traveling forming fabric **26**, suitably supported and driven by rolls **28** and **30**, receives the layered papermaking stock issuing from headbox **10**. Once retained on fabric **26**, the layered fiber suspension passes water through the fabric as shown by the arrows **32**. Water removal is achieved by combinations of gravity, centrifugal force and vacuum suction depending on the forming configuration.

Forming multi-layered paper webs is also described and disclosed in U.S. Patent No. 5,129,988 to Farrington, Jr., which is incorporated herein by reference.

In accordance with the present disclosure, the additive composition, in one embodiment, may be combined with the aqueous suspension of fibers that are fed to the headbox **10**. The additive composition, for instance, may be applied to only a single layer in the stratified fiber furnish or to all layers. When added during the wet end of the process or otherwise combined with the aqueous suspension of fibers, the additive composition becomes incorporated throughout the fibrous layer.

When combined at the wet end with the aqueous suspension of fibers, a retention aid may also be present within the additive composition. For instance, in one particular embodiment, the retention aid may comprise polydiallyl dimethyl ammonium chloride. The additive composition may be incorporated into the tissue web in an amount from about 0.01% to about 30% by weight, such as from about 0.5% to about 20% by weight. For instance, in one embodiment, the additive composition may be present in an amount up to about 10% by weight. The above percentages are based upon the solids that are added to the tissue web.

The basis weight of tissue webs made in accordance with the present disclosure can vary depending upon the final product. For example, the process may be used to produce bath tissues, facial tissues, paper towels, industrial wipers, and the like. In general, the basis weight of the tissue products may vary from about 10 gsm to about 110 gsm, such as from about 20 gsm to about 90 gsm. For bath tissue and facial tissues, for instance, the basis weight may range from about 10 gsm to about 40 gsm. For paper towels, on the other hand, the basis weight may range from about 25 gsm to about 80 gsm.

PCT/US2006/038991

In multiple ply products, the basis weight of each tissue web present in the product can also vary. In general, the total basis weight of a multiple ply product will generally be the same as indicated above, such as from about 20 gsm to about 110 gsm. Thus, the basis weight of each ply can be from about 10 gsm to about 5 60 gsm, such as from about 20 gsm to about 40 gsm.

The tissue web bulk prior to contacting the wiping solution may also vary from about 3 cc/g to 20 cc/g, such as from about 5 cc/g to 15 cc/g. The sheet "bulk" is calculated as the quotient of the caliper of a dry tissue sheet, expressed in microns, divided by the dry basis weight, expressed in grams per square meter. 10 The resulting sheet bulk is expressed in cubic centimeters per gram. More specifically, the caliper is measured as the total thickness of a stack of ten representative sheets and dividing the total thickness of the stack by ten, where each sheet within the stack is placed with the same side up. Caliper is measured in accordance with TAPPI test method T411 om-89 "Thickness (caliper) of Paper, 15 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. The micrometer has a load of 2.00 kilo-Pascals (132 grams per square inch), a pressure foot area of 2500 square millimeters, a pressure foot diameter of 56.42 millimeters, a dwell time of 3 20 seconds and a lowering rate of 0.8 millimeters per second.

Once the aqueous suspension of fibers is formed into a tissue web, the tissue web may be processed using various techniques and methods. For example, referring to **Fig. 2**, shown is a method for making throughdried tissue sheets. (For simplicity, the various tensioning rolls schematically used to define 25 the several fabric runs are shown, but not numbered. It will be appreciated that variations from the apparatus and method illustrated in **Fig. 2** can be made without departing from the general process). Shown is a twin wire former having a papermaking headbox **34**, such as a layered headbox, which injects or deposits a stream **36** of an aqueous suspension of papermaking fibers onto the forming fabric 30 **38** positioned on a forming roll **39**. The forming fabric serves to support and carry the newly-formed wet web downstream in the process as the web is partially dewatered to a consistency of about 10 dry weight percent. Additional dewatering

~~PCT/US06/38991~~

of the wet web can be carried out, such as by vacuum suction, while the wet web is supported by the forming fabric.

The wet web is then transferred from the forming fabric to a transfer fabric **40**. In one embodiment, the transfer fabric can be traveling at a slower speed than the forming fabric in order to impart increased stretch into the web. This is commonly referred to as a "rush" transfer. Preferably the transfer fabric can have a void volume that is equal to or less than that of the forming fabric. The relative speed difference between the two fabrics can be from 0-60 percent, more specifically from about 15-45 percent. Transfer is preferably carried out with the assistance of a vacuum shoe **42** such that the forming fabric and the transfer fabric simultaneously converge and diverge at the leading edge of the vacuum slot.

The web is then transferred from the transfer fabric to the throughdrying fabric **44** with the aid of a vacuum transfer roll **46** or a vacuum transfer shoe, optionally again using a fixed gap transfer as previously described. The throughdrying fabric can be traveling at about the same speed or a different speed relative to the transfer fabric. If desired, the throughdrying fabric can be run at a slower speed to further enhance stretch. Transfer can be carried out with vacuum assistance to ensure deformation of the sheet to conform to the throughdrying fabric, thus yielding desired bulk and appearance if desired. Suitable throughdrying fabrics are described in U.S. Patent No. 5,429,686 issued to Kai F. Chiu et al. and U. S. Patent No. 5,672,248 to Wendt, et al. which are incorporated by reference.

In one embodiment, the throughdrying fabric contains high and long impression knuckles. For example, the throughdrying fabric can have about from about 5 to about 300 impression knuckles per square inch which are raised at least about 0.005 inches above the plane of the fabric. During drying, the web can be macroscopically arranged to conform to the surface of the throughdrying fabric and form a three-dimensional surface. Flat surfaces, however, can also be used in the present disclosure.

The side of the web contacting the throughdrying fabric is typically referred to as the "fabric side" of the paper web. The fabric side of the paper web, as described above, may have a shape that conforms to the surface of the throughdrying fabric after the fabric is dried in the throughdryer. The opposite side

~~PCT/US2006/038991~~

of the paper web, on the other hand, is typically referred to as the "air side". The air side of the web is typically smoother than the fabric side during normal throughdrying processes.

5 The level of vacuum used for the web transfers can be from about 3 to about 15 inches of mercury (75 to about 380 millimeters of mercury), preferably about 5 inches (125 millimeters) of mercury. The vacuum shoe (negative pressure) can be supplemented or replaced by the use of positive pressure from the opposite side of the web to blow the web onto the next fabric in addition to or as a replacement for sucking it onto the next fabric with vacuum. Also, a vacuum
10 roll or rolls can be used to replace the vacuum shoe(s).

While supported by the throughdrying fabric, the web is finally dried to a consistency of about 94 percent or greater by the throughdryer **48** and thereafter transferred to a carrier fabric **50**. The dried basesheet **52** is transported to the reel **54** using carrier fabric **50** and an optional carrier fabric **56**. An optional pressurized
15 turning roll **58** can be used to facilitate transfer of the web from carrier fabric **50** to fabric **56**. Suitable carrier fabrics for this purpose are Albany International 84M or 94M and Asten 959 or 937, all of which are relatively smooth fabrics having a fine pattern. Although not shown, reel calendering or subsequent off-line calendering can be used to improve the smoothness and softness of the basesheet.

20 In one embodiment, the reel **54** shown in **Fig. 2** can run at a speed slower than the fabric **56** in a rush transfer process for building crepe into the paper web **52**. For instance, the relative speed difference between the reel and the fabric can be from about 5% to about 25% and, particularly from about 12% to about 14%. Rush transfer at the reel can occur either alone or in conjunction with a rush
25 transfer process upstream, such as between the forming fabric and the transfer fabric.

In one embodiment, the paper web **52** is a textured web which has been dried in a three-dimensional state such that the hydrogen bonds joining fibers were substantially formed while the web was not in a flat, planar state. For instance, the
30 web can be formed while the web is on a highly textured throughdrying fabric or other three-dimensional substrate. Processes for producing uncreped throughdried fabrics are, for instance, disclosed in U. S. Patent No. 5,672,248 to Wendt, et al.; U. S. Patent No. 5,656,132 to Farrington, et al.; U. S. Patent No.

~~PCT/US06/38991~~

6,120,642 to Lindsay and Burazin; U. S. Patent No. 6,096,169 to Hermans, et al.; U. S. Patent No. 6,197,154 to Chen, et al.; and U. S. Patent No. 6,143,135 to Hada, et al., all of which are herein incorporated by reference in their entireties.

As described above, the additive composition can be combined with the aqueous suspension of fibers used to form the tissue web **52**. Alternatively, the additive composition may be topically applied to the tissue web after it has been formed. For instance, as shown in **Fig. 2**, the additive composition may be applied to the tissue web prior to the dryer **48** or after the dryer **48**.

In **Fig. 2**, a process is shown for producing uncreped through-air dried tissue webs. It should be understood, however, that the additive composition may be applied to tissue webs in other tissue making processes. For example, referring to **Fig. 3**, one embodiment of a process for forming wet creped tissue webs is shown. In this embodiment, a headbox **60** emits an aqueous suspension of fibers onto a forming fabric **62** which is supported and driven by a plurality of guide rolls **64**. A vacuum box **66** is disposed beneath forming fabric **62** and is adapted to remove water from the fiber furnish to assist in forming a web. From forming fabric **62**, a formed web **68** is transferred to a second fabric **70**, which may be either a wire or a felt. Fabric **70** is supported for movement around a continuous path by a plurality of guide rolls **72**. Also included is a pick up roll **74** designed to facilitate transfer of web **68** from fabric **62** to fabric **70**.

From fabric **70**, web **68**, in this embodiment, is transferred to the surface of a rotatable heated dryer drum **76**, such as a Yankee dryer.

In accordance with the present disclosure, the additive composition can be incorporated into the tissue web **68** by being combined with an aqueous suspension of fibers contained in the headbox **60** and/or by topically applying the additive composition during the process. In one particular embodiment, the additive composition of the present disclosure may be applied topically to the tissue web **68** while the web is traveling on the guide rolls **72** or may be applied to the surface of the dryer drum **76** for transfer onto one side of the tissue web **68**. In this manner, the additive composition is used to adhere the tissue web **68** to the dryer drum **76**. In this embodiment, as web **68** is carried through a portion of the rotational path of the dryer surface, heat is imparted to the web causing most of the moisture contained within the web to be evaporated. Web **68** is then removed

PCT/US2006/038991

from dryer drum **76** by a creping blade **78**. Creping web **78** as it is formed further reduces internal bonding within the web and increases softness. Applying the additive composition to the web during creping, on the other hand, may increase the strength of the web.

5 In addition to applying the additive composition during formation of the tissue web, the additive composition may also be used in post-forming processes. For example, in one embodiment, the additive composition may be used during a creping process. Specifically, once topically applied to a tissue web, the additive composition has been found well-suited to adhering the tissue web to a creping
10 surface, such as in a print-creping operation.

For example, once a tissue web is formed and dried, in one embodiment, the additive composition may be applied to at least one side of the web and the at least one side of the web may then be creped. In general, the additive composition may be applied to only one side of the web and only one side of the
15 web may be creped, the additive composition may be applied to both sides of the web and only one side of the web is creped, or the additive composition may be applied to each side of the web and each side of the web may be creped.

Referring to **Fig. 4**, one embodiment of a system that may be used to apply the additive composition to the tissue web and to crepe one side of the web is
20 illustrated. The embodiment shown in **Fig. 4** can be an in-line or off-line process. As shown, tissue web **80** made according to the process illustrated in **Fig. 2** or **Fig. 3** or according to a similar process, is passed through a first additive composition application station generally **82**. Station **82** includes a nip formed by a smooth rubber press roll **84** and a patterned rotogravure roll **86**. Rotogravure roll
25 **86** is in communication with a reservoir **88** containing a first additive composition **90**. Rotogravure roll **86** applies the additive composition **90** to one side of web **80** in a preselected pattern.

Web **80** is then contacted with a heated roll **92** after passing a roll **94**. The heated roll **92** can be heated to a temperature, for instance, up to about 200°C and
30 particularly from about 100°C to about 150°C. In general, the web can be heated to a temperature sufficient to dry the web and evaporate any water.

It should be understood, that the besides the heated roll **92**, any suitable heating device can be used to dry the web. For example, in an alternative

PCT/US2006/038991

embodiment, the web can be placed in communication with an infra-red heater in order to dry the web. Besides using a heated roll or an infra-red heater, other heating devices can include, for instance, any suitable convective oven or microwave oven.

5 From the heated roll **92**, the web **80** can be advanced by pull rolls **96** to a second additive composition application station generally **98**. Station **98** includes a transfer roll **100** in contact with a rotogravure roll **102**, which is in communication with a reservoir **104** containing a second additive composition **106**. Similar to station **82**, second additive composition **106** is applied to the opposite side of web
10 **80** in a preselected pattern. Once the second additive composition is applied, web **80** is adhered to a creping roll **108** by a press roll **110**. Web **80** is carried on the surface of the creping drum **108** for a distance and then removed therefrom by the action of a creping blade **112**. The creping blade **112** performs a controlled pattern creping operation on the second side of the tissue web.

15 Once creped, tissue web **80**, in this embodiment, is pulled through a drying station **114**. Drying station **114** can include any form of a heating unit, such as an oven energized by infra-red heat, microwave energy, hot air or the like. Drying station **114** may be necessary in some applications to dry the web and/or cure the additive composition. Depending upon the additive composition selected,
20 however, in other applications drying station **114** may not be needed.

The amount that the tissue web is heated within the drying station **114** can depend upon the particular thermoplastic resins used in the additive composition, the amount of the composition applied to the web, and the type of web used. In some applications, for instance, the tissue web can be heated using a gas stream
25 such as air at a temperature of about 100°C to about 200°C.

In the embodiment illustrated in **Fig. 4**, although the additive composition is being applied to each side of the tissue web, only one side of the web undergoes a creping process. It should be understood, however, that in other embodiments both sides of the web may be creped. For instance, the heated roll **92** may be
30 replaced with a creping drum such as **108** shown in **Fig. 4**.

Creping the tissue web as shown in **Fig. 4** increases the softness of the web by breaking apart fiber-to-fiber bonds contained within the tissue web. Applying the additive composition to the outside of the paper web, on the other

~~PCT/US2006/038991~~

hand, not only assists in creping the web but also adds dry strength, wet strength, stretchability and tear resistance to the web. Further, the additive composition reduces the release of lint from the tissue web.

5 In general, the first additive composition and the second additive composition applied to the tissue web as shown in **Fig. 4** may contain the same ingredients or may contain different ingredients. Alternatively, the additive compositions may contain the same ingredients in different amounts as desired.

10 The additive composition is applied to the base web as described above in a preselected pattern. In one embodiment, for instance, the additive composition can be applied to the web in a reticular pattern, such that the pattern is interconnected forming a net-like design on the surface.

15 In an alternative embodiment, however, the additive composition is applied to the web in a pattern that represents a succession of discrete shapes. Applying the additive composition in discrete shapes, such as dots, provides sufficient strength to the web without covering a substantial portion of the surface area of the web.

20 According to the present disclosure, the additive composition is applied to each side of the paper web so as to cover from about 15% to about 75% of the surface area of the web. More particularly, in most applications, the additive composition will cover from about 20% to about 60% of the surface area of each side of the web. The total amount of additive composition applied to each side of the web can be in the range of from about 1% to about 30% by weight, based upon the total weight of the web, such as from about 1% to about 20% by weight, such as from about 2% to about 10% by weight.

25 At the above amounts, the additive composition can penetrate the tissue web after being applied in an amount up to about 30% of the total thickness of the web, depending upon various factors. It has been discovered, however, that most of the additive composition primarily resides on the surface of the web after being applied to the web. For instance, in some embodiments, the additive composition penetrates the web less than 10%, such as less than 5%, such as less than 3% of the thickness of the web.

Referring to **Fig. 5**, one embodiment of a pattern that can be used for applying an additive composition to a paper web in accordance with the present

PCT/US2006/038991

disclosure is shown. As illustrated, the pattern shown in **Fig. 5** represents a succession of discrete dots **120**. In one embodiment, for instance, the dots can be spaced so that there are approximately from about 25 to about 35 dots per inch in the machine direction or the cross-machine direction. The dots can have a diameter, for example, of from about 0.01 inches to about 0.03 inches. In one particular embodiment, the dots can have a diameter of about 0.02 inches and can be present in the pattern so that approximately 28 dots per inch extend in either the machine direction or the cross-machine direction. In this embodiment, the dots can cover from about 20% to about 30% of the surface area of one side of the paper web and, more particularly, can cover about 25% of the surface area of the web.

Besides dots, various other discrete shapes can also be used. For example, as shown in **Fig. 7**, a pattern is illustrated in which the pattern is made up of discrete shapes that are each comprised of three elongated hexagons. In one embodiment, the hexagons can be about 0.02 inches long and can have a width of about 0.006 inches. Approximately 35 to 40 hexagons per inch can be spaced in the machine direction and the cross-machine direction. When using hexagons as shown in **Fig. 7**, the pattern can cover from about 40% to about 60% of the surface area of one side of the web, and more particularly can cover about 50% of the surface area of the web.

Referring to **Fig. 6**, another embodiment of a pattern for applying an additive composition to a paper web is shown. In this embodiment, the pattern is a reticulated grid. More specifically, the reticulated pattern is in the shape of diamonds. When used, a reticulated pattern may provide more strength to the web in comparison to patterns that are made up on a succession of discrete shapes.

The process that is used to apply the additive composition to the tissue web in accordance with the present disclosure can vary. For example, various printing methods can be used to print the additive composition onto the base sheet depending upon the particular application. Such printing methods can include direct gravure printing using two separate gravures for each side, offset gravure printing using duplex printing (both sides printed simultaneously) or station-to-station printing (consecutive printing of each side in one pass). In another embodiment, a combination of offset and direct gravure printing can be used. In

PCT/US06/38991

still another embodiment, flexographic printing using either duplex or station-to-station printing can also be utilized to apply the additive composition.

Referring to **Fig. 8**, another alternative embodiment for printing the additive composition onto a tissue web in order to crepe the web is illustrated. In this embodiment, in comparison to the embodiment illustrated in **Fig. 4**, the additive composition is only applied to one side of the tissue web. Like reference numerals have been used to indicate similar elements.

As shown, a web **80** is advanced to an additive composition application station generally **98**. Station **98** includes a transfer roll **100** in contact with a rotogravure roll **102**, which is in communication with a reservoir **104** containing an additive composition **106**. At station **98**, the additive composition **106** is applied to one side of the web **80** in a preselected pattern.

Once the additive composition is applied, web **80** is adhered to a creping roll **108** by a press roll **110**. Web **80** is carried on the surface of the creping drum **108** for a distance and then removed therefrom by the action of a creping blade **112**. The creping blade **112** performs a controlled pattern creping operation on the treated side of the web.

From the creping drum **108**, the tissue web **80** is fed through a drying station **114** which dries and/or cures the additive composition **106**. The web **80** is then wound into a roll **116** for use in forming multiple ply products.

When only treating one side of the tissue web **80** with an additive composition, in one embodiment, it may be desirable to apply the additive composition according to a pattern that covers greater than about 40% of the surface area of one side of the web. For instance, the pattern may cover from about 40% to about 60% of the surface area of one side of the web. In one particular example, for instance, the additive composition can be applied according to the pattern shown in **Fig. 7**.

Tissue webs incorporating the additive composition as described in any of the above embodiments generally have a bulk of greater than about 3 cc/g, such as greater than about 8 cc/g, such as greater than about 10 cc/g, such as even greater than about 11 cc/g. The tissue webs may have a basis weight of from about 6 gsm to about 110 gsm or greater. For instance, the basis weight of the

PCT/US2006/038991

tissue webs can range from about 10 gsm to about 40 gsm in one embodiment or, alternatively, from about 20 gsm to about 80 gsm.

Once a tissue web is produced according to one of the above described processes incorporating the additive composition, in accordance with the present disclosure, the web can be embossed, crimped, and/or laminated with other webs by applying pressure and/or heat to the web containing the additive composition and then saturated with a wiping solution. During the process, the additive composition can form embossments in the product and/or can form bond areas for bonding the tissue web to other adjacent webs. Use of the additive composition enhances the embossing, crimping or lamination process in several ways. For instance, the embossed pattern can be much more defined due to the presence of the additive composition. Further, the embossing is not only liquid resistant but, unexpectedly, it has been discovered that a tissue web containing the additive composition can be embossed without substantially weakening the web. In particular, it has been discovered that a tissue web containing the additive composition can be embossed without reducing the tensile strength of the web in either the machine direction or the cross machine direction by more than about 5%. In fact, in some embodiments, the tensile strength of the web may actually be increased after the embossing process.

For purposes of illustration, one embodiment of a process for embossing a tissue web according to the present disclosure is illustrated in **Fig. 9**. As shown in the figure, a tissue web **160** can be fed into an embossing nip **150**. In the embodiment illustrated in **Fig. 9**, only a single tissue web is embossed. It should be understood, however, that in other embodiments multiple webs may be fed into the embossing nip **150** for forming a multi-ply product. For example, the separate plies of the multi-ply product can be brought adjacent to one another from separate parent rolls or directly from separate production lines placed upstream of the embossing nip **150**.

When forming multiple ply products, the resulting tissue product may comprise two plies, three plies, or more. Each adjacent ply may contain the additive composition or at least one of the plies adjacent to one another may contain the additive composition. The individual plies can generally be made from

the same or from a different fiber furnish and can be made from the same or a different process.

The moisture content of the tissue web **160** as it enters the embossing nip **150** may vary depending upon the particular application and the process conditions. For example, in one embodiment, the tissue web can be fairly dry when entering the embossing nip. The moisture content of the tissue web, for instance, can be less than about 10% by weight of the web, such as less than about 8% by weight of the web, such as less than about 5% by weight of the web.

The embossing nip **150** is formed between a pattern roll **152** and a backing roll **154**. The embossing nip **150** is configured to apply sufficient pressure and/or heat in order to cause the thermoplastic polymer contained within the additive composition to soften. By softening the polymer, the polymer flows within the tissue web and forms defined embossments. Further, when feeding multiple plies into the embossing nip, the additive composition forms bond areas which laminates the plies together. In general, the pattern roll **152** and/or the backing roll **154** may be maintained at a temperature of from ambient up to about 150°C., such as from about 50°C to about 90°C. The pressure exerted on the tissue web within the nip **150** may vary depending upon whether or not one or more of the rolls is heated. In general, the nip pressure can be from about 200 psi to about 500 psi, such as from about 250 psi to about 350 psi.

Residence time of the one or more tissue webs within the embossing nip **150** can also vary depending upon various factors, such as the line speed as well as the roll diameters. In general, the residence time of the tissue web in the embossing nip **150** can be from about 2 milliseconds to about 100 milliseconds, such as from about 2 milliseconds to about 25 milliseconds. In general, the longer the residence time in the embossing nip **150**, the lower the pressure and temperature required in order to obtain the desired amount of defined embossments.

In the embodiment shown in **Fig. 9**, the pattern roll **152** is heated during the embossing process. For example, a liquid such as oil can be heated in a remote chamber **156** and continuously circulated via a control valve **158** to route the oil along the interior surface of the pattern roll **152**.

~~PCT/US2006/038991~~

It should be understood, however, that various other methods of heating the pattern roll **152** and/or the backing roll **154** may be employed. For example, the rolls may be heated by circulating a supply of heated water, gas, steam or the like. Alternatively, rather than circulating a heated fluid within one of the rolls, the rolls
5 may be heated by an electrical heat generating device or by way of induction heating. Other suitable methods of providing thermal energy to the embossing nip **150** may include infrared, radiant or a conductive heat generating device. A combination of heating methods can also be employed.

Additionally, the tissue web **160** may be preheated prior to entering the
10 embossing nip **150**. For instance, the tissue web may be preheated by guiding the web around a heated roll prior to entering the embossing nip **150**.

In still another embodiment, the additive composition of the present disclosure may be topically applied to the tissue web **160** just prior to the web entering the embossing nip **150**. In this manner, the additive composition may be
15 heated and thus can already be in a softened state prior to entering the embossing nip **150**.

The backing roll **154** can be any suitable backing roll which can support the nip pressure necessary to suitably emboss the tissue web **160** under the desired process conditions. The backing roll **154**, for instance, may comprise a rubber
20 coated backing roll. For instance, the backing roll **154** can include a rigid inner shell covered by a resilient elastomeric material. The elastomeric material covering the resilient roll may be any suitable material, such as, for example, a polyurethane.

Alternatively, the backing roll **154** can be a mated steel roll having a pattern
25 that matches the pattern on the pattern roll **152**. In still another embodiment, the backing roll **154** can comprise a smooth steel roll, commonly referred to as an anvil roll.

The process of the present disclosure can be used to simply emboss a decorative pattern into the tissue web **160**. Alternatively, the presence of the
30 additive composition in the tissue web **160** can be used to bond the tissue web to an adjacent ply in order to form a multi-ply product.

In one embodiment, a visible pattern may be embossed into the tissue web **160**. For instance, the pattern roll **152** can include raised pattern elements. The

~~PCT/US2006/038991~~
pattern elements can form any desired decorative pattern in the tissue web. The decorative pattern can be visually recognizable and aesthetically pleasing. The decorative pattern can include straight lines, curved lines, flowers, butterflies, leaves, animals, toys, monograms, words, symbols and the like. The pattern can be made up of separate discrete shapes or can comprise a reticulated grid. The pattern may also comprise a combination of a reticulated pattern and discrete shapes. In general, the pattern can cover between about 1% and about 80% of the surface area of the sheet, such as from about 2% to about 60% of the surface area of the sheet. For example, in one embodiment, the embossing pattern can cover from about 5% to about 30% of the surface area of the sheet.

One possible embodiment of a pattern roll **152** is shown in greater detail in **Fig. 10**. The pattern roll **152** can be, for instance, a rigid steel roll with the pattern elements formed by engraving or other suitable techniques. As can be seen, the surface of the pattern roll **152** includes reticulated raised bonding elements **168** that are separated by smooth land areas **166**. The raised bonding elements **168** are desirably arranged to form a decorative pattern, though the elements can alternatively be discrete elements arranged in a random fashion. The bonding elements **168** can be raised above the surface of the land areas **166** a distance such that the pressure in the embossing nip **150** at the intimate areas of contact between the bonding elements **168** and the tissue web **160** are sufficient to emboss the tissue web as desired. Generally, the bonding elements **168** are raised above the land areas **166** at least about 0.01 inch and particularly from about 0.02 inch to about 0.06 inch.

Referring to **Fig. 11**, a tissue product **164** is shown that is intended to represent a tissue product that may be formed in conjunction with use of the pattern roll **152** as shown in **Fig. 10**. The tissue product represented in **Fig. 11** may be a single ply product or may comprise a multi-ply product. As shown, the pattern roll **152** forms well defined embossments within the tissue web **164**. The embossments are well defined due to the presence of the additive composition. When the tissue product **164** comprises a multi-ply tissue product, the embossments **170** also comprise bond areas where the multiple plies are held together by the additive composition.

PCT/US2006/038991

After the single ply or multi-ply product is formed, the product is then impregnated with a wiping solution for use as a premoistened product. The wiping solution can comprise any suitable solution that will not degrade the one or more plies.

5 For example, when used as a baby wipe, for instance, the wiping solution may contain water, one or more surfactants, and/or an emollient. The solution may also contain, for instance, one or more glycols. Examples of glycols include propylene glycol, or polyethylene glycol. Various other ingredients may also be incorporated into the wiping solution such as fragrances, aloe, and the like. The
10 wiping solution may be alcohol-free or may contain an alcohol.

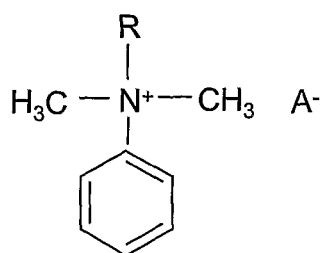
 When used to clean adjacent surfaces, for instance, the wiping solution may contain one or more alcohols combined with water. The alcohol may be, for instance, an aliphatic alcohol having from about 1 to about 6 carbon atoms. By way of example, the alcohol may be methanol, ethanol, propanol, isopropanol,
15 butanol, t-butanol, 2-butanol, pentanol, 2-pentanol, hexanol, 2,3-dimethyl-1-butanol, and the like, including mixtures of two or more alcohols.

 In general, the wiping solution can contain water in an amount less than about 50% by weight. For instance, in one embodiment, the solution may contain alcohol in an amount greater than about 60% by weight, such as from about 60%
20 by weight to about 80% by weight. Greater amounts of alcohol, however, may be used.

 The wiping solution may also contain various other additives. Such other additives include disinfectants, antiseptics, emollients, skin conditioners, anti-microbial agents such as sterilants, sporicides, germicides, bactericides,
25 fungicides, virucides, protozoacides, algicides, bacteriostats, fungistats, virustats, sanitizers, and antibiotics, fragrances, anti-drying agents, and the like.

 Example of anti-drying agents include glycols and glycerides. Examples of anti-microbial agents, on the other hand, include quaternary ammonium compounds, such as quaternary ammonium halide compounds. In some
30 embodiments, quaternary ammonium halide compounds having the following formula are utilized:

PCT/US06/38991



wherein,

R is a C₈-C₁₈ alkyl group; and

A is a halogen atom, such as chlorine, bromine, fluorine, and the like.

- 5 One commercially available example of an antimicrobial agent that includes such a quaternary ammonium compound is available under the trade name BARDAC® 208M from Lonza, Inc., Fairlawn, N.J. Specifically, BARDAC® 208M contains a blend of alkyl dimethyl benzyl ammonium chlorides. Other commercially available examples of suitable quaternary ammonium compounds
- 10 are believed to include BARDAC® 2050 and BARDAC® 2080 (based on dialkyl(C₈-C₁₀)dimethyl ammonium chloride); BARDAC® 2250 and BARDAC® 2280 (didecyl dimethyl ammonium chloride); BARDAC® LF and BARDAC® LF 80 (based on dioctyl dimethyl ammonium chloride); BARQUAT® MB-50 and BARQUAT® MB-80 (based on alkyl dimethyl benzyl ammonium chloride); BARQUAT® MX-50 and
- 15 BARQUAT® MX-80 (based on alkyl dimethyl benzyl ammonium chloride); BARQUAT® OJ-50 and BARQUAT® OJ-80 (based on alkyl dimethyl benzyl ammonium chloride); BARQUAT® 4250, BARQUAT® 4280, BARQUAT® 4250Z, and BARQUAT® 4280Z (based on alkyl dimethyl benzyl ammonium chloride and/or alkyl dimethyl ethyl benzyl ammonium chloride); and BARQUAT® MS-100
- 20 (based on myristyl dimethyl benzyl ammonium chloride), which are available from Lonza, Inc., Fairlawn, N.J.

- Other anti-microbial agents that may be used in the present disclosure include halogenated diphenyl ethers like 2,4,4'-trichloro-2'-hydroxy-diphenyl ether (Triclosan® or TCS) or 2,2'-dihydroxy-5,5'-dibromo-diphenyl ether; phenolic
- 25 compounds like phenoxyethanol, phenoxy propanol, phenoxyisopropanol, para-chloro-meta-xylene (PCMX), etc.; bisphenolic compounds like 2,2'-methylene bis (4-chlorophenol), 2,2'-methylene bis (3,4,6-trichlorophenol), 2,2'-methylene bis (4-

~~PCT/US06/38991~~

chloro-6-bromophenol), bis (2-hydroxy-3,5-dichlorophenyl) sulphide, and bis (2-hydroxy-5-chlorobenzyl)sulphide; halogenated carbanilides (e.g., 3,4,4'-trichlorocarbanilides (Triclocarban® or TCC); benzyl alcohols; chlorhexidine; chlorhexidine gluconate; and chlorhexidine hydrochloride.

5 The wiping solution impregnated into the tissue sheet may also contain one or more surfactants. Surfactants can provide a number of benefits to the resulting wiper. For instance, surfactants can increase the wettability of the wiping product, can serve as emollients, can improve the ability of the wiping product to clean surfaces, and can also serve to stabilize the wiping solution itself. In general, any
10 suitable nonionic, anionic, cationic and amphoteric surfactant may be incorporated into the wiping solution.

 In some embodiments, the wiping solution can also contain one or more preservatives. Suitable preservatives include, for instance, Kathon CG®, which is a mixture of methylchloroisothiazolinone and methylisothiazolinone available from
15 Rohm & Haas; Mackstat H 66 (available from McIntyre Group, Chicago, IL); DMDM hydantoin (e.g., Glydant Plus, Lonza, Inc., Fair Lawn, NJ); iodopropynyl butylcarbamate; benzoic esters (parabens), such as methylparaben, propylparaben, butylparaben, ethylparaben, isopropylparaben, isobutylparaben, benzylparaben, sodium methylparaben, and sodium propylparaben; 2-bromo-2-
20 nitropropane-1,3-diol; benzoic acid; amidazolidinyl urea; diazolidinyl urea; and the like. Other suitable preservatives include those sold by Sutton Labs, such as "Germall 115" (amidazolidinyl urea), "Germall II" (diazolidinyl urea), and "Germall Plus" (diazolidinyl urea and iodopropynyl butylcarbonate).

 In general, any of the above additives may be present in the wiping solution
25 in an amount less than about 20% by weight, such as less than about 5% by weight. For instance, many of the additives may be present in an amount from about 0.001% to about 2% by weight.

 Once the tissue sheet is impregnated with a wiping solution, the wiping products may be packaged as desired. For instance, the wiping product may be
30 packaged in a resealable container. Some examples of suitable containers include rigid tubs, film pouches, etc. One particular example of a suitable container for holding the wipers is a rigid, cylindrical tub (e.g., made from polyethylene) that is fitted with a resealable air-tight lid on the top portion of the container. The lid has a

PCT/US2006/038991

hinged cap initially covering an opening positioned beneath the cap. The opening allows for the passage of wipers from the interior of the sealed container whereby individual wipers can be removed by grasping the wiper.

5 In another embodiment, the wiper may be held in a liquid impermeable pouch that has an ovular shaped opening. The opening may be covered by a tab that is attached to the pouch by a pressure sensitive adhesive. The tab may be opened to remove a wiper and then resealed against the pouch.

The pre-saturated wipers may be cut into individual sheets that are folded and stacked together. In an alternative embodiment, the wiping product may be
10 spirally wound to form a roll. In this embodiment, the individual wipers may be separated by a perforation.

The present disclosure may be better understood with reference to the following examples.

EXAMPLE NO. 1

15 A tissue web was constructed and topically treated with an additive composition made in accordance with the present disclosure. The tissue web was then subjected to an embossing process similar to the one illustrated in **Fig. 9**. During the embossing process, a pattern roll was heated to a temperature of approximately 80°C. The strength of the embossed tissue web was then
20 compared with the strength of the tissue web prior to embossing.

Tissue basesheets

The following process was used to produce a 3-layer uncreped through-air dried base web in a process similar to the process shown in **Fig. 2**. The basesheet had a basis weight of about 30 gsm.

25 Air-dried northern softwood kraft (NSWK) pulp from the Terrace Bay, ON, Canada mill of Neenah Paper Inc. was placed into a pulper and disintegrated for 30 minutes at 4% consistency at 120 degrees Fahrenheit. The NSWK pulp was then transferred to a dump chest and subsequently diluted to approximately 3% consistency. The NSWK pulp was diluted to about 2% consistency, pumped to a
30 machine chest and diluted with fresh water to reduce the machine chest consistency to about 0.2-0.3%.

Air-dried Aracruz ECF, a eucalyptus hardwood Kraft (EHWK) pulp available from Aracruz, located in Rio de Janeiro, RJ, Brazil, was placed into a pulper and

PCT/US2006/038991

disintegrated for 30 minutes at about 4% consistency at 120 degrees Fahrenheit.

The EHWK pulp was then transferred to a dump chest and subsequently diluted to about 2% consistency.

5 Next, the EHWK pulp slurry was diluted, divided into two equal amounts, and pumped at about 1% consistency into two separate machine chests. This pulp slurry was subsequently diluted to about 0.1% consistency. The two EHWK pulp fibers represent the two outer layers of the 3-layered tissue structure.

10 Approximately 2 kilograms per metric ton of wood fiber PAREZ® 631 NC, available from LANXESS Corporation., located in Trenton, New Jersey, U.S.A, was added to the stuff boxes, mixing with the pulp fibers before pumping the pulp slurry through the headbox. The pulp fibers from all three machine chests were pumped to the headbox at a consistency of about 0.1%. Pulp fibers from each machine chest were sent through separate manifolds in the headbox to create a 3-layered tissue structure. The fibers were deposited on a forming fabric. Water
15 was removed by vacuum.

20 The wet sheet, about 10-15% consistency, was transferred to a transfer fabric that was moving approximately 28% slower than the forming fabric. The basesheet was then dewatered to about 15-25% consistency and transferred to an additional fabric. The sheet and fabric were dried utilizing hot air of approximately 400 degrees F in a through dryer and wound into soft rolls for converting.

Chemical Application Process

 The uncreped through air-dried tissue sheet was coated with a chemical composition utilizing 2 rotogravure printers in a typical printing process described as a print-print application.

25 The printing process consisted of the tissue web being fed into a gravure printing line where the additive composition was printed onto the surface of the sheet. One side of the sheet was printed using direct rotogravure printing. The sheet was printed with a 0.020 diameter "dot" pattern as shown in **Fig. 5** wherein 28 dots per inch were printed on the sheet in both the machine and cross-machine
30 directions. The resulting surface area coverage was approximately 25%. The solids of the solution being printed were controlled to approximately 30% to provide a 5% dry polymer add-on per dry tissue weight per printed side. The sheet traveled from the first print station to a second identical print station where the

PCT/US2006/038991

second side of the tissue was coated in a similar fashion. The sheet was then passed through a throughdryer that dried the printed web to approximately 95% solids utilizing an air temperature of approximately 120°C.

Chemical Applied

5 The samples were treated with an additive composition made in accordance with the present disclosure. The polyolefin dispersion consisted of 70% of the polymer designated as "PBPE" - an experimental propylene-based plastomer or elastomer ("PBPE") having a density of 0.867 grams/cm³ as measured by ASTM D792, a melt flow rate of 25 g/10 min. at 230°C and 2.16 kg as measured by
10 ASTM D1238, and an ethylene content of 12% by weight of the PBPE and 30 wt% of PRIMACOR™ 5980i copolymer. The PRIMACOR™ 5980i copolymer is an ethylene-acrylic acid copolymer obtained from The Dow Chemical Company and has a Melt Index of 13.75g/10 min at 125C per 2.16 kg following ASTM D1238. The ethylene-acrylic acid copolymer can serve not only as a thermoplastic polymer
15 but also as a dispersing agent. The dispersion also contained DOWICIL™ 200 antimicrobial obtained from The Dow Chemical Company, which is a preservative with the active composition of 96% cis 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride(also known as Quaternium-15).

Embossing Process

20 The single ply samples were placed on a linerboard carrier sheet and fed through a lab 3 roll Beloit Wheeler Calender stack fitted with a magnesium embossing sleeve, with a diamond-like pattern (similar to the pattern in Figure 10). The tissue sample side with the chemical application was positioned so that it was in contact with the embossing sleeve. The calendar was heated to ~ 80° C.

25 The following test was then performed on the embossed tissue web and compared to the tissue web prior to embossing:

Tensile Strength

 The tensile test that was performed used tissue samples that were conditioned at 23° C+/-1°C and 50% +/-2% relative humidity for a minimum of 4
30 hours. The 2-ply samples were cut into 3 inch wide strips in the machine direction (MD) and cross-machine direction (CD) using a precision sample cutter model JDC 15M-10, available from Thwing-Albert Instruments, a business having offices located in Philadelphia, Pennsylvania, U.S.A.

~~PCT/US06/38991~~

The gauge length of the tensile frame was set to four inches. The tensile frame was an Alliance RT/1 frame run with TestWorks 4 software. The tensile frame and the software are available from MTS Systems Corporation, a business having offices located in Minneapolis, Minnesota, U.S.A.

5 A 3" strip was then placed in the jaws of the tensile frame and subjected to a strain of 10 inches per minute until the point of sample failure. The stress on the tissue strip is monitored as a function of the strain. The calculated outputs included the peak load (grams-force/3", measured in grams-force), the peak stretch (% , calculated by dividing the elongation of the sample by the original
10 length of the sample and multiplying by 100%), the % stretch @ 500 grams-force, the tensile energy absorption (TEA) at break (grams-force*cm/cm², calculated by integrating or taking the area under the stress-strain curve up to 70% of sample failure), and the slope A (kilograms-force, measured as the slope of the stress-strain curve from 57-150 grams-force).

15 Each tissue code was tested in the machine direction (MD) and cross-machine direction (CD).

 The results of the testing are graphically illustrated in **Figs. 12** and **13**. As shown, even though embossing is known to deteriorate the strength of a tissue web, the strength of the web actually increased due to the presence of the additive
20 composition. Thus, the strength of the webs were increased prior to being contacted with a wiping solution.

EXAMPLE NO. 2

 To illustrate the properties of products made in accordance with the present disclosure, various tissue webs were constructed and topically treated with an
25 additive composition. The tissue webs were then plied together and subjected to an embossing process similar to the one illustrated in **Fig. 9**. During the embossing process, a pattern roll was heated to a temperature of approximately 80°C. The pressure and heat of the embossing process allowed the thermoplastic to flow between the plies creating a multi-ply laminate structure.

30 The properties of the embossed laminate structure were compared with the strength of the tissue webs prior to embossing. Additionally, an untreated tissue sample, and a tissue sample treated with an ethylene-vinyl acetate copolymer binder were also tested to show the benefits of incorporation of additive

~~PCT/US2006/038991~~

compositions made according to the present disclosure. Such benefits are particularly advantageous once the webs are contacted with a wiping solution.

Tissue Basesheets

5 The following process was used to produce an uncreped through-air dried base web in a process similar to the process shown in Fig. 2. The basesheet had a basis weight of about 30 gsm.

Initially, 80 pounds of air-dried northern softwood kraft (NSWK) pulp from the Terrace Bay, ON, Canada mill of Neenah Paper Inc. was placed into a pulper and disintegrated for 15 minutes at 4% consistency at 120 degrees Fahrenheit.
10 Then, the NSWK pulp was refined for 9 minutes, transferred to a dump chest and subsequently diluted to approximately 3% consistency. (Note: Refining fibrillates fibers to increase their bonding potential). Additionally, 80 pounds of air-dried southern softwood kraft (SSWK) pulp from the Mobile, AL, USA mill of Alabama Pine Inc. was placed into a pulper and disintegrated for 15 minutes at 4%
15 consistency at 120 degrees Fahrenheit. Then, the SSWK pulp was refined for 9 minutes, transferred to a dump chest and subsequently diluted to approximately 3% consistency. The SSWK and NSWK pulp were diluted to about 2% consistency and pumped to a machine chest, in a manner that the machine chest contained 20 air-dried pounds of a 1:1 ratio of SSWK to NSWK. The mixture was
20 then diluted with fresh water to reduce the machine chest consistency to about 0.2-0.3%.

Eight kilograms KYMENE® 6500, available from Hercules, Incorporated, located in Wilmington, Delaware, U.S.A., per metric ton of wood fiber was added and allowed to mix with the pulp fibers for at least 10 minutes before pumping the
25 pulp slurry through the headbox. The pulp fibers from all three machine chests were pumped to the headbox at a consistency of about 0.1%. The fibers were deposited on a forming fabric. Water was subsequently removed by vacuum.

The wet sheet, about 10-15% consistency, was transferred to a transfer fabric that was moving approximately 28% slower than the forming fabric. The
30 basesheet was then where it was further dewatered, to about 15-25% consistency and transferred to an additional fabric. The sheet and fabric were dried utilizing hot air of approximately 400 degrees F in a through dryer wound onto a 3" core into soft rolls for converting.

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A second tissue basesheet was made utilizing the process shown in **Fig. 3** to produce a creped base web. The basesheet had a basis weight of about 13.5 gsm. In this process the polyolefin composition was applied topical through spraying the additives onto the Yankee dryer prior to contacting the dryer with the tissue web. For purposes of comparison, samples were also produced using a standard PVOH/KYMENE crepe package.

Initially, 80 pounds of air-dried softwood kraft (NSWK) pulp was placed into a pulper and disintegrated for 15 minutes at 4% consistency at 120 degrees F. Then, the NSWK pulp was refined for 15 minutes, transferred to a dump chest and subsequently diluted to approximately 3% consistency. (Note: Refining fibrillates fibers to increase their bonding potential.) Then, the NSWK pulp was diluted to about 2% consistency and pumped to a machine chest, such that the machine chest contained 20 air-dried pounds of NSWK at about 0.2-0.3% consistency. The above softwood fibers were utilized as the inner strength layer in a 3-layer tissue structure.

Two kilograms KYMENE® 6500, available from Hercules, Incorporated, located in Wilmington, Delaware, U.S.A., per metric ton of wood fiber and two kilograms per metric ton of wood fiber PAREZ® 631 NC, available from LANXESS Corporation., located in Trenton, New Jersey, U.S.A., was added and allowed to mix with the pulp fibers for at least 10 minutes before pumping the pulp slurry through the headbox.

Forty pounds of air-dried Aracruz ECF, a eucalyptus hardwood Kraft (EHWK) pulp available from Aracruz, located in Rio de Janeiro, RJ, Brazil, was placed into a pulper and disintegrated for 30 minutes at about 4% consistency at 120 degrees Fahrenheit. The EHWK pulp was then transferred to a dump chest and subsequently diluted to about 2% consistency.

Next, the EHWK pulp slurry was diluted, divided into two equal amounts, and pumped at about 1% consistency into two separate machine chests, such that each machine chest contained 20 pounds of air-dried EHWK. This pulp slurry was subsequently diluted to about 0.1% consistency. The two EHWK pulp fibers represent the two outer layers of the 3-layered tissue structure.

~~PCT/US06/38991~~

Two kilograms KYMENE® 6500 per metric ton of wood fiber was added and allowed to mix with the hardwood pulp fibers for at least 10 minutes before pumping the pulp slurry through the headbox.

5 The pulp fibers from all three machine chests were pumped to the headbox at a consistency of about 0.1%. Pulp fibers from each machine chest were sent through separate manifolds in the headbox to create a 3-layered tissue structure. The fibers were deposited and on a forming fabric. Water was subsequently removed by vacuum.

10 The wet sheet, about 10-20% consistency, was transferred to a press felt or press fabric where it was further dewatered. The sheet was then transferred to a Yankee dryer through a nip via a pressure roll. The consistency of the wet sheet after the pressure roll nip (post-pressure roll consistency or PPRC) was approximately 40%. The wet sheet adhered to the Yankee dryer due to an adhesive that is applied to the dryer surface. Spray booms situated underneath
15 the Yankee dryer sprayed either an adhesive package, which is a mixture of polyvinyl alcohol/KYMENE®/Rezsol 2008M, or an additive composition according to the present disclosure onto the dryer surface. Rezsol 2008M is available from Hercules, Incorporated, located in Wilmington, Delaware, U.S.A.

20 One batch of the typical adhesive package on the continuous handsheet former (CHF) typically consisted of 25 gallons of water, 5000mL of a 6% solids polyvinyl alcohol solution, 75mL of a 12.5% solids KYMENE® solution, and 20mL of a 7.5% solids Rezsol 2008M solution. The additive compositions according to the present disclosure were applied at a solids content of approximately 5%.

25 The sheet was dried to about 95% consistency as it traveled on the Yankee dryer and to the creping blade. The creping blade subsequently scraped the tissue sheet and small amounts of dryer coating off the Yankee dryer. The creped tissue basesheet was then wound onto a 3" core into soft rolls for converting.

Chemical Application Process

30 The uncreped through air-dried tissue sheets were coated with several chemical compositions utilizing either a rotogravure printer in a typical printing process or by a rotogravure printer followed by a creping step in a process described as print creping.

~~PCT/US2006/038991~~

During the printing process, the tissue web was fed into a gravure printing line where the additive composition was printed onto the surface of the sheet. One side of the sheet was printed using direct rotogravure printing. The sheet was printed with a 0.020 diameter "dot" pattern as shown in **Fig. 5** wherein 28 dots per inch were printed on the sheet in both the machine and cross-machine directions. The resulting surface area coverage was approximately 25%. The solids of the solution being printed were controlled to approximately 30% to provide a 5% dry polymer add-on per dry tissue weight per printed side. The sheet traveled from the first print station to a second identical print station where the second side of the tissue was coated in a similar fashion. The sheet was then passed through a throughdryer that dried the printed web to approximately 95% solids utilizing an air temperature of approximately 120°C.

The print creping process is generally illustrated in Fig. 8. The sheet was fed to a gravure printing line where the additive composition was printed onto the surface of the sheet. One side of the sheet was printed using direct rotogravure printing. The sheet was printed with a 0.020 diameter "dot" pattern as shown in Fig. 5 wherein 28 dots per inch were printed on the sheet in both the machine and cross-machine directions. The resulting surface area coverage was approximately 25%. The sheet was then pressed against and doctored off a rotating drum, which had a surface temperature of 100°C. The solids of the solution being printed were controlled to approximately 30% to provide a 5% dry polymer add-on per dry tissue weight per printed side. The second side of the sheet was printed and creped in a similar method on the second side before the sheet was wound into a roll at an approximately 95% solids level.

Chemicals Applied

For samples treated with additive compositions made in accordance with the present disclosure, the following table provides the components of the additive composition for each sample. The olefin polymer dispersion used contained 60 wt% AFFINITY™ EG8200 plastomer and 40 wt% of PRIMACOR™ 5980i copolymer. The AFFINITY™ EG8200 is an alpha-olefin interpolymer comprising an ethylene and octene copolymer that was obtained from The Dow Chemical Company of Midland, Michigan, U.S.A. It has a Melt Index of 5g/10 min at 190C per 2.16 kg following ASTM D1238. The PRIMACOR™ 5980i copolymer is an

PCT/US2006/038991

ethylene-acrylic acid copolymer also obtained from The Dow Chemical Company and has a Melt Index of 13.75g/10 min at 125C per 2.16 kg following ASTM D1238. The ethylene-acrylic acid copolymer can serve not only as a thermoplastic polymer but also as a dispersing agent. The dispersion also contained

- 5 DOWICIL™ 200 antimicrobial obtained from The Dow Chemical Company, which is a preservative with the active composition of 96% cis 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride(also known as Quaternium-15). The olefin polymer dispersion had a solids content of 42%, an average volumetric particle size of 1.6, a poly dispersity of 2.2, and a pH of 11.
- 10 Additionally controls were made utilizing a formulation containing primarily of a commercially available ethylene- vinyl acetate copolymer emulsion obtained from Air Products, Inc. under the trade name AIRFLEX® 426. The AIRFLEX® 426 (63% solids) was mixed with KYMENE® 6500 (12.5% solids) available from Hercules, Incorporated, located in Wilmington, Delaware, U.S.A; HERCOBOND®
- 15 1366 (7.5% solids) available from Hercules, Incorporated, located in Wilmington, Delaware, U.S.A; PROTOCOL® Defoamer (100% solids) available from Hercules, Incorporated, located in Wilmington, Delaware, U.S.A;, and NaOH (10% solids) to achieve a pH of approximately 7. The final formulation % dry weight consisted of 91% AIRFLEX® 426, 6% KYMENE® 6500, 2% HERCOBOND® 1366, and 1%
- 20 PROTOCOL® Defoamer.

<u>Sample ID</u>	<u>Composition Applied to the Sample</u>	<u>Method of Addition</u>	<u>Approximate Composition add-on (%)</u>
Control 1	Untreated UCTAD	N/A	2
Control 2	AIRFLEX® 426 Binder	Printed	2
Control 3	Control Creped tissue	N/A	3
Example 1	AFFINITY™ EG8200 / PRIMACOR™ 5980i (60/40)	Printed	2
Example 2	AFFINITY™ EG8200 / PRIMACOR™ 5980i (60/40)	Print-Creped	2

~~PCT/US2006/038991~~

Example 3	AFFINITY™ EG8200 / PRIMACOR™ 5980i (60/40)	Crepe Package	3
Example 4	AIRFLEX® 426 Binder – exterior side AFFINITY™ EG8200 / PRIMACOR™ 5980i (60/40) – interior side	Printed	2

Embossing Process

Before embossing and creating 2 ply samples, the tissue was positioned so
 5 that the printed or treated side was on the inside of the structures. For 3 ply
 structures the middle ply was not particularly positioned but the two outer plies
 were positioned so that the side was on the inside of the structures.

The samples were placed on a linerboard carrier sheet and fed through a
 lab 3 roll Beloit Wheeler Calender stack fitted with a magnesium embossing
 10 sleeve, with a criss-cross pattern. The samples were embossed at a pressure of
 20 pli at 20 fpm at a temperature of 80°C.

Testing

The following tests were conducted on the samples:

Wet/Dry Tensile Test (% in the cross-machine direction), Geometric Mean Tensile
 15 Strength (GMT), and Geometric Mean Tensile Energy Absorbed (GMTEA):

The tensile tests that was performed used tissue samples that were
 conditioned at 23° C+/-1°C and 50% +/-2% relative humidity for a minimum of 4
 hours. The 2-ply samples were cut into 3 inch wide strips in the machine direction
 (MD) and cross-machine direction (CD) using a precision sample cutter model JDC
 20 15M-10, available from Thwing-Albert Instruments, a business having offices
 located in Philadelphia, Pennsylvania, U.S.A.

The gauge length of the tensile frame was set to four inches. The tensile
 frame was an Alliance RT/1 frame run with TestWorks 4 software. The tensile
 frame and the software are available from MTS Systems Corporation, a business
 25 having offices located in Minneapolis, Minnesota, U.S.A.

PCT/US06/38991

A 4" strip was then placed in the jaws of the tensile frame and subjected to a strain of 10 inches per minute until the point of sample failure. The stress on the tissue strip is monitored as a function of the strain. The calculated outputs included the peak load (grams-force/3", measured in grams-force), the peak stretch (%), calculated by dividing the elongation of the sample by the original length of the sample and multiplying by 100%), the % stretch @ 500 grams-force, the tensile energy absorption (TEA) at break (grams-force*cm/cm², calculated by integrating or taking the area under the stress-strain curve up to 70% of sample failure), and the slope A (kilograms-force, measured as the slope of the stress-strain curve from 57-150 grams-force).

Wet tensile strength was measured in the same manner as dry strength except that the samples were wetted prior to testing. Specifically, in order to wet the sample, a 3"x 5" tray was filled with distilled or deionized water at a temperature of 23± 2°C. The water is added to the tray to an approximate one cm depth.

A 3M "Scotch-Brite" general purpose scrubbing pad is then cut to dimensions of 2.5"x 4". A piece of masking tape approximately 5" long is placed along one of the 4" edges of the pad. The masking tape is used to hold the scrubbing pad.

The scrubbing pad is then placed into the water with the taped end facing up. The pad remains in the water at all times until testing is completed. The sample to be tested is placed on blotter paper that conforms to TAPPI T205. The scrubbing pad is removed from the water bath and tapped lightly three times on a screen associated with the wetting pan. The scrubbing pad is then gently placed on the sample parallel to the width of the sample in the approximate center. The scrubbing pad is held in place for approximately one second. The sample is then immediately put into the tensile tester and tested. To calculate the wet/dry tensile strength ratio, the wet tensile strength value was divided by the dry tensile strength value.

Each tissue code (minimum of five replicates) was tested in the machine direction (MD) and cross-machine direction (CD). Geometric means of the tensile strength and tensile energy absorption (TEA) were calculated on the dry tissue tests as the square root of the product of the machine direction (MD) and the

PCT/US2006/038991

cross-machine direction (CD). This yielded an average value that is independent of testing direction. The samples that were used are shown below.

The results of the testing are shown in the following tables. As shown, even though embossing is known to deteriorate the strength of a tissue web, the strength of the web actually increased due to the presence of the additive composition.

<u>Sample ID</u>	<u>Basis Wt</u> <u>(gsm)</u>	<u>Number of</u> <u>Plies</u>	<u>Plies</u> <u>Laminated</u>
Control 1	60	2	No
Control 2	66	2	No
Control 3	41	3	No
Example 1	66	2	Yes
Example 2	66	2	Yes
Example 3	41	3	Yes
Example 4	66	2	Yes

This above table indicates the presence of the olefin polymer dispersion was necessary to laminate the plies.

<u>Sample ID</u>	<u>Basesheet</u> <u>GMT</u> <u>(g/3")</u>	<u>Post-embossing</u> <u>GMT</u> <u>(g/3")</u>	<u>Basesheet</u> <u>GMTEA</u> <u>(gram-cm/cm2)</u>	<u>Post-embossing</u> <u>GMTEA</u> <u>(gram-cm/cm2)</u>
Control 1	3960	3280	58	44
Control 2	7880	6460	98	92
Control 3	810	540	23	14
Example 1	5290	6080	69	88
Example 2	4230	4840	92	95
Example 3	2420	2900	37	31
Example 4	6870	6650	99	97

The above table indicates how the olefin dispersion increased the GMT and

PCT/US2006/038991
GMTEA during thermal embossing.

<u>Sample ID</u>	<u>Pre-embossing Wet/Dry</u>	<u>Post-embossing Wet/Dry</u>
	<u>Avg. (Std Dev) (%)</u>	<u>Avg. (Std Dev) (%)</u>
Control 1	31	31
Control 2	41	43
Control 3	24	25
Example 1	38	55
Example 2	43	51
Example 3	39	58
Example 4	40	52

5 The above table indicates how the olefin dispersion increased the wet/dry during thermal embossing.

10 These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention, which is more particularly set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to limit the invention so further described in such appended claims.

PCT/US2006/038991
What Is Claimed:

1. A premoistened tissue product comprising:
a tissue web comprising pulp fibers, the tissue web containing an additive composition, the additive composition comprising a non-fibrous olefin polymer, an ethylene-carboxylic acid copolymer, or mixtures thereof, the tissue
5 web including densified areas that have a defined structure in the tissue web that is formed by the additive composition; and
a wiping solution incorporated into the tissue web.
2. A premoistened tissue product as defined in claim 1, wherein the tissue product is a single ply tissue product.
3. A premoistened tissue product as defined in claim 1, wherein the product comprises a multiple ply product, the additive composition forming bond areas between the tissue web and an adjacent web.
4. A premoistened tissue product as defined in claim 1, 2 or 3, wherein the densified areas comprise embossments that are visible from at least one side of the tissue web.
5. A premoistened tissue product as defined in claim 4, wherein the embossments define a pattern, the pattern comprising a reticulated pattern.
6. A premoistened tissue product as defined in claim 1, 2, 3, 4 or 5, wherein the tissue web has been formed according to a wetlaid process.
7. A premoistened tissue product as defined in any of the preceding claims, wherein the additive composition comprises the olefin polymer and the olefin polymer comprises an alpha-olefin interpolmer of ethylene and at least one comonomer selected from the group consisting of a C₄ to C₂₀ linear, branched or
5 cyclic diene, vinyl acetate, and a compound represented by the formula H₂C=CHR, wherein R is a C₁ to C₂₀ linear, branched or cyclic alkyl group or a C₆ to C₂₀ aryl group.
8. A premoistened tissue product as defined in any of the preceding claims, wherein the additive composition comprises the olefin polymer and the olefin polymer comprises a copolymer of propylene with at least one comonomer selected from the group consisting of ethylene, a C₄ to C₂₀ linear, branched or
5 cyclic diene, and a compound represented by the formula H₂C=CHR, wherein R is a C₁ to C₂₀ linear, branched or cyclic alkyl group or a C₆ to C₂₀ aryl group.

PCT/US06/38991

9. A premoistened tissue product as defined in any of the preceding claims, wherein the additive composition further comprises a dispersing agent.
10. A premoistened tissue product as defined in claim 9, wherein the dispersing agent comprises a carboxylic acid, a salt of a carboxylic acid, a carboxylic acid ester, or a salt of a carboxylic acid ester.
11. A premoistened tissue product as defined in claim 9, wherein the dispersing agent comprises the ethylene-carboxylic acid copolymer.
12. A premoistened tissue product as defined in claim 1, 2, 3, 4, 5, or 6, wherein the additive composition comprises a mixture of the olefin polymer and the ethylene-carboxylic acid copolymer, the ethylene-carboxylic acid copolymer comprising an ethylene-acrylic acid copolymer, the olefin polymer comprises an
5 interpolymers of ethylene and an alkene, and wherein the additive composition further comprises a carboxylic acid.
13. A premoistened tissue product as defined in any of the preceding claims, wherein the additive composition is present on or in the tissue web in an amount from about 0.1% to about 20% by weight.
14. A premoistened tissue product as defined in claim 1, 2, 3, 4, 5 or 6, wherein the additive composition comprises the olefin polymer and wherein the olefin polymer has a particle size of from about 0.1 micron to about 5 microns prior to being incorporated into the tissue web.
15. A premoistened tissue product as defined in any of the preceding claims, wherein the wiping solution comprises an alcohol and water, the alcohol being present in the wiping solution in an amount of at least 60% by weight.
16. A premoistened tissue product as defined in any of the preceding claims, wherein the wiping solution comprises at least one surfactant.
17. A premoistened tissue product as defined in any of the preceding claims, wherein the tissue web is made from a fiber furnish that consists essentially of pulp fibers.
18. A process for producing a premoistened tissue product comprising:
incorporating an additive composition into a tissue web, the additive composition comprising a non-fibrous olefin polymer, an ethylene-carboxylic acid copolymer, or mixtures thereof, the tissue web containing pulp fibers;

PCT/US2006/038991

5

embossing the web to form densified areas that have a defined structure that is supported by the additive composition; and

contacting the tissue web with a wiping solution in order to form the premoistened tissue product.

19. A process as defined in claim 18, wherein the densified areas comprise embossments that are visible from at least one side of the tissue web.

20. A process as defined in claim 19, wherein the embossments define a pattern, the pattern comprising a reticulated pattern.

21. A process as defined in claim 19, wherein the embossments define a pattern, the pattern comprising a pattern of discrete shapes.

22. A process as defined in claim 18, 19, 20 or 21, wherein the additive composition further comprises a dispersing agent.

23. A process as defined in claim 22, wherein the dispersing agent comprises a carboxylic acid, a salt of a carboxylic acid, a carboxylic acid ester, or a salt of a carboxylic acid ester.

24. A process as defined in claim 22, wherein the dispersing agent comprises the ethylene-carboxylic acid copolymer.

25. A process as defined in claim 18, 19, 20 or 21, wherein the additive composition comprises a mixture of the olefin polymer and the ethylene-carboxylic acid copolymer, the ethylene-carboxylic acid copolymer comprising an ethylene-acrylic acid copolymer, the olefin polymer comprising an interpolymer of ethylene and an alkene, and wherein the additive composition further comprises a
5 carboxylic acid.

26. A process as defined in claim 18 through 24 or 25, wherein the additive composition is present on or in the tissue web in an amount from about 0.1% to about 20% by weight.

27. A process as defined in claim 18 through 25 or 26, wherein the additive composition is topically applied to the tissue web.

28. A process as defined in claim 18 through 26 or 27, wherein the tissue web is embossed together with a second tissue web, the densified areas forming bond areas between the adjacent webs.

29. A process as defined in claim 18 through 27 or 28, wherein the tissue web is formed from an aqueous suspension of pulp fibers.

PCT/US2006/038991

30.

A process as defined in claim 18 through 28 or 29, wherein the wiping solution comprises an alcohol, a surfactant, an antimicrobial agent, or mixtures thereof.