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(54) **METHOD OF BINDING MINERAL PARTICLES TO FIBERS**

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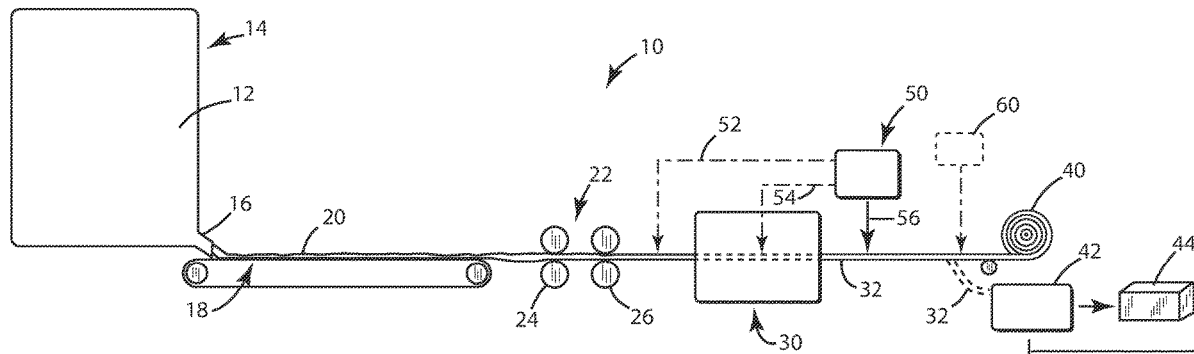
(57) **ABSTRACT**

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A method for bonding or adding thermo-reactive minerals, such as tourmaline, and/or antimicrobial to fibers, fabrics, textiles and/or any organic, synthetic, or combination thereof, hard surfaces for the therapeutic benefits associated with thermo-reactive minerals. The improved method includes an optical brightener for visually determining the presence and distribution of the mineral and antimicrobial.

**Related U.S. Application Data**

(63) Continuation of application No. 16/585,610, filed on Sep. 27, 2019.



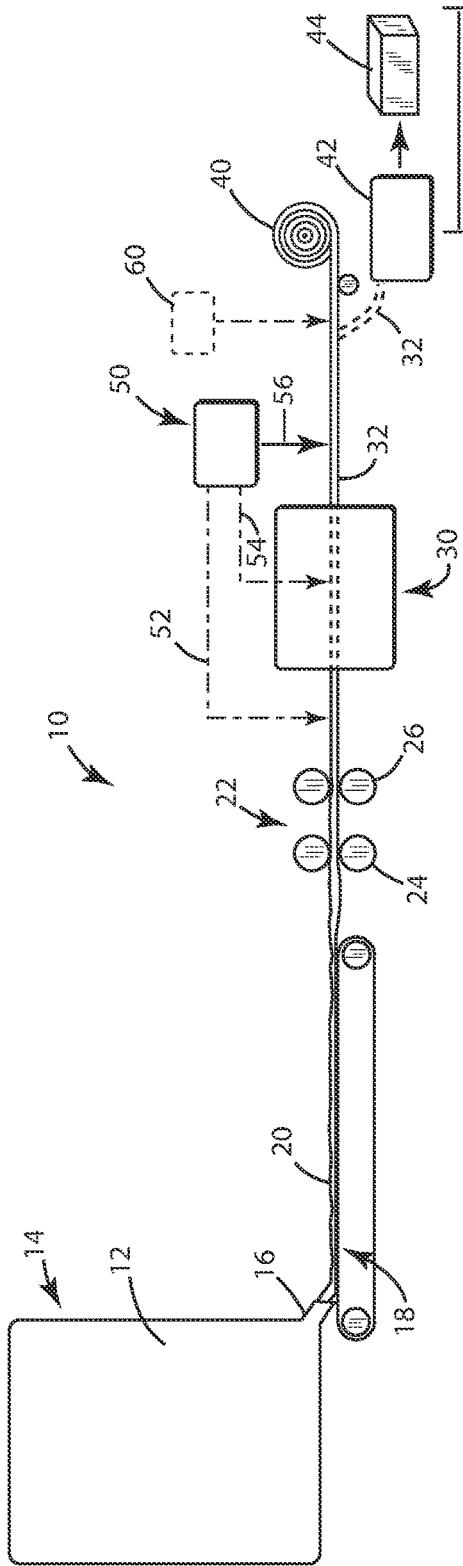


FIG. 1

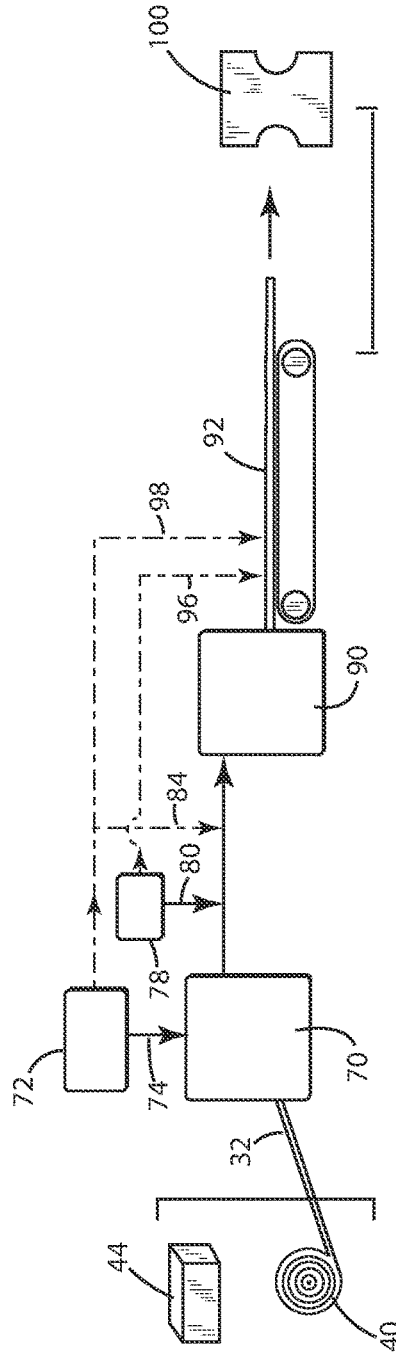


FIG. 2

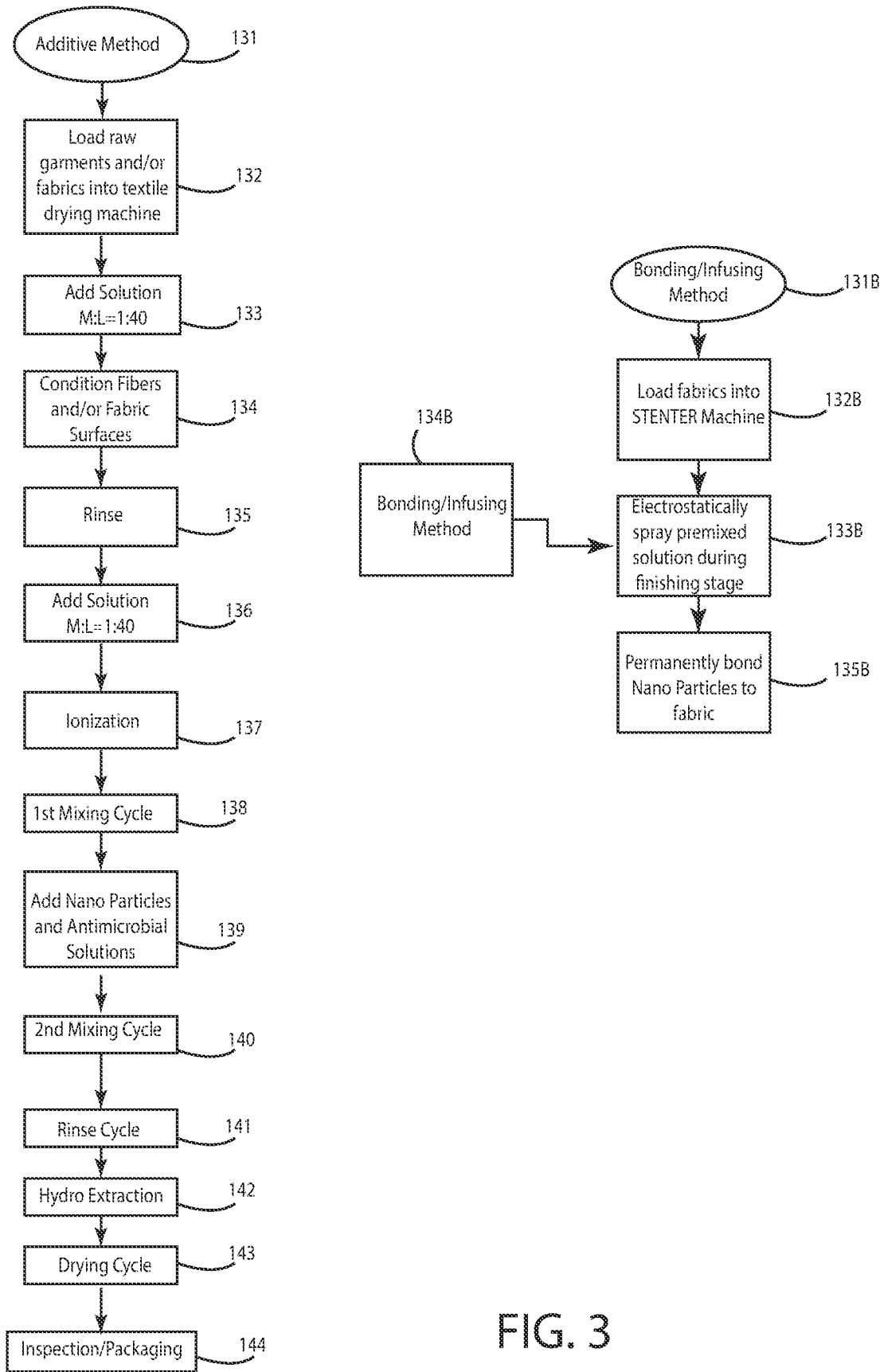


FIG. 3

## METHOD OF BINDING MINERAL PARTICLES TO FIBERS

### TECHNICAL FIELD

**[0001]** This invention concerns non-polymeric binders for particles and the use of such binders in binding mineral particles to fibers, garments, fabrics, or hard surfaces.

### BACKGROUND

**[0002]** Methods of applying binders to fibrous webs are known in the art. Such binders are not commonly described as being useful in binding mineral particulates to fibers, or to fibrous surfaces. Crosslinking agents such as polycarboxylic acids that form covalent intra-fiber bonds with individualized cellulose fibers are also known in the art. The covalent intra-fiber bonds are formed at elevated temperatures and increase the bulk of cellulose fibers treated with the crosslinker by forming intra-fiber ester crosslinks. Crosslinking must occur under acidic conditions to prevent reversion of the ester bonds.

**[0003]** Many different types of particles may be added to fibers for different end uses. Antimicrobials and fire retardants are but a few examples of particles that are added to fibers. It would be advantageous to provide a method of attaching health inducing mineral particles that could be accommodated to the many different particle needs of end users, e.g., general health and wellness, reduction of pain, inflammation and mitochondrial dysfunction, increase in healthy sleep, microcirculation and accelerated healing.

### SUMMARY

**[0004]** The present invention provides bonding, by infusion and/or application of mineral particles of the micron and/or nanometer range sizes and/or an antimicrobial, such as, for example, but not limited to SIS 200D™ or PATHOGARD™. One or both of these types of components are in an aqueous mixture along with bonding and stabilizing components.

**[0005]** For example, the mixture may contain:

**[0006]** Bactericidal·Virucidal\* Active Ingredients:

**[0007]** Octyl decyl dimethyl ammonium chloride

**[0008]** Dioctyl dimethyl ammonium chloride

**[0009]** Didecyl dimethyl ammonium chloride

**[0010]** Alkyl (C14; C12; C16)

**[0011]** Dimethyl benzyl ammonium chloride

**[0012]** 3-(trimethoxysilyl) propyldimethyloctadecyl

**[0013]** Ammonium chloride\*\*

**[0014]** [Other] [Inert] Ingredients

\*\*Active Ingredient is hydrolyzed to produce methanol. The final concentration of the active ingredient and methanol are: 3-(trihydroxysilyl) propyldimethyloctadecyl ammonium chloride

**[0015]** The mixture may be sprayed on, applied with a fogger or to be exhausted on a fabric, fiber or textile. The fabrics, fibers, or textiles may include cellulose acetate fibers, cotton or tree pulp cellulose (biopolymers), nylon fibers, polyester, Rayon (including viscose, modal, lyocell, satin, brocades and/or taffetas), hemp fibers, and/or bamboo fibers. An Optical Brightener may also be used in order to visually test as an indicator of the duration that the bonding has occurred and to ensure proper and even disbursement of particles for coverage on the surfaces being applied to and upon. These applications may be applied to; fibers, textiles,

fabrics and/or inanimate objects/fomites. The setting of the application may be accomplished through air drying or heat setting.

### DESCRIPTION OF THE DRAWINGS

**[0016]** The subject matter which is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other objects, features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

**[0017]** FIG. 1 is a schematic illustration of a wet laid sheet manufacturing line illustrating the application of binder coated particles in accordance with the present invention during the manufacture of a fiber sheet;

**[0018]** FIG. 2 is a schematic illustration of a web manufacturing line illustrating binder reactivation and particulate attachment process in accordance with the present invention; and

**[0019]** FIG. 3 is a method flow chart illustrating processes for bonding nano particles to fabrics and for adding nano particles to garments.

### DESCRIPTION

**[0020]** FIG. 1 illustrates a wet laid sheet manufacturing line such as a pulp sheet manufacturing line 10. In this manufacturing line, pulp slurry 12 is delivered from a headbox 14 through a slice 16 and onto a Fourdrinier wire 18. The pulp slurry 12 typically includes cellulose fibers such as wood pulp fibers and may also include synthetic or other non-cellulose fibers as part of the slurry. Water is drawn from the pulp deposited on wire 18 by a conventional vacuum system, not shown, leaving a deposited pulp sheet 20 which is carried through a dewatering station 22, illustrated in this case as two sets of calendar rolls 24, 26 each defining a respective nip through which the pulp sheet or mat 20 passes. From the dewatering station, the pulp sheet 20 enters a drying section 30 of the pulp manufacturing line. In a conventional pulp sheet manufacturing line, drying section 30 may include multiple canister dryers with the pulp mat 20 following a serpentine path around the respective canister dryers 35 and emerging as a dried sheet or mat 32 from the outlet of the drying section 30.

**[0021]** Other alternate drying mechanisms, alone or in addition to canister dryers, may be included in the drying stage 30. The dried pulp sheet 32 has a maximum moisture content pursuant to the manufacturer's specifications. Typically, the maximum moisture content is no more than 10% by weight of the fibers and most preferably no more than about 6% to 8% by weight. Otherwise, the fibers tend to be too damp. Unless overly damp fibers are immediately used, these fibers are subject to degradation by mold or the like. The dried sheet 32 is taken up on a roll 40 for transportation to a remote location. Alternatively, the dried sheet 32 is collected in a baling apparatus 42 from which bales of the pulp 44 are obtained for transport to a remote location.

**[0022]** A binder of the type explained in detail below is applied to particles and then the binder containing particles are applied to the pulp sheet from one or more particle applying devices, one of which is indicated at 50 in FIG. 1. Any binder applying device may be used for applying binder to particles, such as sprayers, or immersion applicators or the like. Sprayers are typically easier to utilize and incor-

porate into a pulp sheet manufacturing line. The binder is applied to the particles and then the particles are deposited onto the pulp sheet where the binder adheres the particles to the fibers of the sheet. The binder also may be sprayed or otherwise applied to the particles as they fall or are otherwise deposited onto the sheet. Also, the binder may be combined with the particles at another location, allowed to dry or become inactive, and then applied to the sheet. The binder may then be activated as explained below. Also, the moisture in the sheet may be enough to activate the binder for binding particles to the fibers. As indicated by the arrows **52**, **54** and **56**, the binder containing particles may be applied at various locations or at multiple locations on the pulp sheet manufacturing line, such as ahead of the drying stage **30** (indicated by line **52**), intermediate the drying stage **30** (as indicated by line **54**), or downstream from the drying stage **30** (as indicated by the line **56**). It will be understood that the binder in the present invention is activated at approximately **175** degrees Fahrenheit.

**[0023]** Particles with water-soluble binders, such as non-polymeric urea, are typically applied at a location where sufficient drying can still take place in the drying stage to produce a dried binder particle containing fiber sheet with no more than the maximum desired moisture content. Consequently, to take advantage of the drying stage **30**, particles with wet water-based binders may be applied at locations **52** or **54**. If wet water-based binder containing particles are applied at location **56** in an amount which would cause the moisture content of the sheet to exceed the desired maximum level, an additional drying stage (not shown) may be included in the pulp manufacturing line to bring the moisture content down to the desired level.

**[0024]** The binder containing particulate materials, selected as explained below, may be added to the sheet and adhered thereto by the binders on the pulp manufacturing line. Another suitable particulate applicator is indicated at **60** and may comprise a bulk or volumetric metering device. These particles may be sprinkled, poured, sprayed or otherwise added to the sheet. To facilitate the adherence of these particulates to the sheet at this location, enough moisture must remain in the sheet or on the particles, in the case of aqueous binders on the particles, to enable the bonding between the particles and fibers as explained below.

**[0025]** Although the above approach is advantageous because the particles are strongly bound to the fibers, during transportation of rolls or bales of these fibers it is possible for particles to become dislodged by mechanical impact during transport. In addition, this approach interferes with the customization of the fiber application at a user's location. For example, a user may want the capability of selecting particular types or brands of particles for adherence to the fibers in the user's products, without having this selection made by a pulp-sheet manufacturer who incorporates the particles into the pulp sheet during its manufacture. Therefore, it is also advantageous to provide a fibrous product in which the end user of the product may incorporate the desired particles with binders at the time the fibers are converted into products.

**[0026]** Therefore, in keeping with this latter preferred approach, as illustrated in FIG. **2**, the respective rolls **40** or bales **44** of fibers, without particles, are transported to a remote location for use by a user. These rolls or bales (or otherwise transported fibers, e.g., bagged, containerized or otherwise in bulk form) are then refiberized by a fiberizing

apparatus **70**. Although any fiberizer may be used, a typical fiberizing apparatus **70** is a hammermill which may be used alone or in conjunction with other devices such as picker rolls or the like for breaking up the sheet **32** or bales **42** into individual fibers.

**[0027]** A particulate material adding mechanism **72** (e.g. like mechanism **60**) delivers the desired binder coated particulate materials to the fibers at the desired location in the user's process. Again, the device **72** typically comprises a metering mechanism, although any suitable device for adding particulates to fibrous materials may be used. For example, the particulates may be delivered as indicated by line **74** to the fiberizing apparatus **70**. In the case of some binders, agitation of fibers within the fiberizer **70**, as explained in greater detail below, reactivates the binders and causes the particulates to be adhered to the fibers by the binder. Alternatively, a reactivating fluid, which may be a liquid such as, for example water, glycerin, lower-alkyl alcohols, polyols, acetone, and combinations thereof, such as water and glycerin, may be sprayed or otherwise applied to the fibers, such as from a reactivation fluid tank or source **78** by way of a sprayer (not shown) at location **80**. The particles may then be applied, as indicated by line **84** to the fibers downstream from the application of the reactivation liquid **80**. The binder on the particles may be reactivated by the activating fluid to adhere to the fibers. Alternatively, the binder containing particles may be added prior to or at location **80** where they are adhered to the fibers by the binder upon reactivation of the binder at location **80**.

**[0028]** Binder may also be combined with the particles as the particles are added to the fiber sheet. As yet another alternative, the fiberized fibers are delivered to an air-laying device **90** and reformed into a desired product such as a web indicated at **92**. In the case of air-laid fibers, the reactivation fluid or liquid may be applied to the web at location **96** with the binder containing particles then being added at location **98** as shown with the reactivated binder then adhering the particles to the fibers. The particles with binder may be applied at a location in the process upstream from the application of the reactivating liquid at location **96**.

**[0029]** Alternatively, the activating fluid may be added simultaneously with the addition of binder coated particles, so that the reactivation occurs simultaneously with the addition of particles. The reactivating fluid also may be added after the binder coated particles are added to the fibers. In addition, the binder coated particles may be applied to specifically defined locations on the web **92**, such as in target zones of a product, thereby minimizing the wasting of the particulate material. A specific example of a target zone is the skin contact region of a bandage where most skin contact would occur and all fiber related materials. The application of health inducing thermo reactive mineral particles, such as, for example, one or a combination of more than one of the following minerals; tourmaline (or any boron silicate mineral), amethyst, jade, moldavite, selenite, vanadinite, emerald and pyromorphite, to such a zone places these particles at a location where they are most useful in providing health benefits.

**[0030]** Other minerals include:

**[0031]** Gold, Shilajit, Shungite and Orgoni.

**[0032]** Nano Ionic Multiple Minerals:

**[0033]** Boron, Calcium, Chromium, Copper, Iodine, Iron, Magnesium, Manganese, Potassium, Selenium, Silica, Sulphur and Zinc.

**[0034]** Nano Ionic Immune Formula:  
**[0035]** Zinc, Selenium, Sulphur and Silver  
**[0036]** Nano Ionic Bone Formula:  
**[0037]** Boron, Calcium, Copper, Magnesium, Manganese, Silica, Sulfur and Zinc.  
**[0038]** Nano Ionic Joint Formula:  
**[0039]** Silica and Sulphur  
**[0040]** Nano Ionic Silica:  
**[0041]** Silica  
**[0042]** Nano Ionic Magnesium:  
**[0043]** Magnesium  
**[0044]** It will be appreciated that combinations of the above nano-sized mineral formulas may aid and/or comfort anyone with inflammation, osteoporosis, osteopenia, infection, joint and muscle issues, hair loss, menstrual irregularities, menopause, perimenopause, prostate inflammation and/or enlargement, cancer or degenerative diseases.  
**[0045]** The web **92**, with or without other components of the end user's product, is then processed into the user's product, such as being included within a bandage or transdermal delivery device **100** and all fiber related materials.  
**[0046]** Again, with this approach, the end user of the fibers may readily select particles to be applied to its product and may, if required, activate the binder as required to enhance the efficient production of the user's product. In addition, the user has flexibility in air laying fibers with binder-coated particles or otherwise combining the binder coated particles into a finished product with the desired particulates. Not only is handling and shipping of the particulate-containing products avoided by the manufacturer of the pulp sheet, enhanced adhesion of particulates to the fibers results because the particles are not subjected to mechanical forces between the location of manufacture of the fibers and the location at which the particulate materials and binder are added.  
**[0047]** The present invention includes a method of binding particles to fibers, and the product, including microbial quaternary inhibitors—Tape, Wristbands, Scarves, Blankets, Arm/Leg Sleeves, equine wraps, pet mats, ace bandages, co-band bandages, pillows, pillowcases, mattress covers, beds, and seat cushions and end-products, that are produced by such method. The method of binding particles to fibers includes cross linking the mineral particles to the fibers and cross linking the mineral particulates to the cross-linked optical brightener and antimicrobial. It will be appreciated that this method allows for detection of remaining mineral particulates and/or antimicrobial via black light inspection.  
**[0048]** The fibers also can be any of a variety of other natural or synthetic fibers; however, all of the fibers to which particles are attached in accordance with the present invention include a cationic functionality. This does not preclude the blending of such fibers with fibers lacking this characteristic.  
**[0049]** In accordance with the present invention, mineral particles are added to the fibers to give the fibers desired properties, such as, increased health benefits and antimicrobial activity.  
**[0050]** In accordance with this invention, the binders may be applied to particles before, or simultaneously with, addition of the particles to the fibers. One approach is to simply spray, as by a mist or fog, the binder onto the particles as the particles are delivered to the fibers. Simultaneous addition can be accomplished by two separate streams of particles and binder that are simultaneously directed at a fibrous

substrate, or alternatively merged immediately or some time prior to impacting against the substrate.

**[0051]** In one embodiment of this invention the binding agent may be any suitable fabric protector such as, surface activation cationic absorbent surfactants (bonding agent). However, it will be appreciated that any suitable short chain, non-polymeric binding agent may be used.

**[0052]** Further in accordance with this invention the delivery device **100** may be adhered to the skin via pressure sensitive adhesive or bandage wraps. Other adhesives are known to the art, including natural, isobutyl and butyl rubber compositions and acrylate-based adhesives and pressure sensitive adhesives.

**[0053]** The configuration of the delivery device for the sustained delivery or application of mineral particles of the micron and/or nanometer range sizes and/or an antimicrobial to the skin can be adhesive matrix, liquid or solid-state reservoir or polymer matrix. In an adhesive matrix type patch, there is an impermeable backing, a matrix comprising the mineral particles of the micron and/or nanometer range sizes and/or an antimicrobial, optionally comprising a permeation enhancer and/or an anti-irritant, and a release liner.

**[0054]** In most transdermal delivery systems, thin, flexible occlusive films serve as protective backing substrate and release liner. For the present skin care applications, an occlusive protective backing substrate is preferred over a non-occlusive backing substrate. The materials used for liner and backing provide storage stability by keeping the active ingredients from migrating into or through the backing material and liner before use. The peel force required to remove the release liner from the patch should be sufficient to prevent inadvertent separation of the liner from the patch before use and low enough so that it can be readily removed by the intended user. The acrylic adhesive can optionally include a cross-linking agent.

**[0055]** Liquid and solid-state reservoir transdermal delivery devices are configured so that the reservoir comprising the mineral particles, listed supra, of the micron and/or nanometer range sizes and/or an antimicrobial, enhancers and any other formulation ingredients is located between the backing material and the adhesive, and during use, formulation ingredients pass through the adhesive and then into the skin. Compatibility of various excipients and penetration enhancers with adhesives are well known to the art, and the skilled artisan can readily choose suitable concentrations and combinations of ingredients and adhesives.

**[0056]** Referring also to FIG. **3** there is shown a method flow chart illustrating a process for bonding or adding nano particles to the surfaces of fabric or garment fibers. It will be appreciated that bonding thermo reactive nano particles to the surface of fabric or garment fibers exposes the thermo reactive nano particle to more direct contact with thermal generation and improves the thermo reactive nano particle response. It will be appreciated that the fabrics and/or garments may be synthetic or non-synthetic. It will also be appreciated that the nano particles may be any suitable thermo reactive mineral, such as, tourmaline for the generation of far infrared waves and negative ions. Other suitable minerals include, for example, gold, platinum, or meteorites.

**[0057]** Beginning with the additive method **131**. Garments or fabrics are loaded into a textile dyeing machine **132**. A water solution (M:L=1:40) is added to the dyeing machine **133**. The application for bonding the nano particles to fabrics includes: Padding—cycling the garment dye

machine with mixing paddles that agitate the solutions and materials together; pH of the prepared bath: approx. 4.0-6.0 Pick-up: approx. 40-80%, depending on the fiber, Bath temperature: about 20-25° C., Drying temperature: 110-130° C., and Separate curing: 5 min at 150° C. on curing machine or Rapid curing process: 45-60 sec at 110-170° C. in stages (Stenter finishing)

**[0058]** The next step **134** conditions the fibers and or fabric surfaces of the garments or fabrics. Conditioning the fabrics and/or fibers includes using a solvent scour (desizing agent) such as, STARTEX™ SCOUR NFP and also includes controlling re-deposition of additives. A preferable desizing agent will have a wide temperature stability range that will remove sizing and soil from fabric which resists usual scouring procedures. It's a one-bath system of scouring and dyeing/infusing fabrics, synthetics and cotton blends. The desizing agent is also compatible with alkalis, dilutes acids and includes anionic surfactants and/or nonionic surfactants that precondition the fabric and garments that will be infused with the nano-particles sized particles. It will be appreciated that this step ensures the surface of fiber and soft/hard surfaces are conditioned and cleaned of dirt and other foreign material prior to adding the infusion process that attaches the nano-size minerals to the conditioned surfaces.

**[0059]** Still referring to FIG. 3, the next steps **135**, **135** rinses the fabrics before the pre-conditioning ionization step **137**. A defoamer such as, for example, STARDEFOAM™ CDF is used in the pre-conditioning cationization of the fibers and surfaces in preparation for a fabric protector surfactant & binding agent, such as, for example, PHOBOL® CP-R). The defoamer is a chemical additive that reduces and hinders the formation of foam in industrial processes liquids.

**[0060]** The defoamer additive, preferably 0.2% to 0.3%, and ph 10-11, is mixed in the water bath for approximately 10 minutes to prevent formation of foam or to break down foam already formed. A preferable defoamer is insoluble in the foaming medium and has surface active properties. An essential feature of a defoamer additive is a low viscosity and a facility to spread rapidly on foamy surfaces. The defoamer additive has affinity to the air-liquid surface where it destabilizes the foam lamellas. This causes rupture of the air bubbles and breakdown of surface foam. The entrained air bubbles are agglomerated, and the larger bubbles quickly rise to the surface of the bulk liquid.

**[0061]** The defoamer, allows for the surfactant, such as, for example, PHOBOL® CP-R, to have superior adherence, bonding and attachability of the nano-sized minerals and/or antimicrobial to the fibers and to hard and soft surfaces.

**[0062]** Optical White Brightener (OWB) may also be added at this stage. It will be appreciated that the textile optical whitening makes the treated fabrics more visible with night vision devices than non-treated ones and assists in quality checks to ensure proper patterned dispersion and distribution of the nano-particles adhering to the fibers and fabric surfaces.

**[0063]** Fabric protector-surface activation cationic absorbent surfactants (bonding agent), such as, PHOBOL® CP-R, is added as an adhesive to infuse, or bond, the nano particles to the fiber/surface when applying the fabric protector additive formula. It will be appreciated that any suitable cationic surfactant and/or infusion bonding mixture may be used.

**[0064]** Step **137** dilutes fabric protector, such as, PHOBOL® CP-R with roughly an equal amount of cold water and adds to a bath containing acetic acid. It is used together with cellulose cross-linking agents, fillers, and other additives. When using cellulose cross-linking agents for cellulose and cellulose/blends it is not necessary to add acetic acid to the bath.

**[0065]** Still referring to FIG. 3, step **138** thoroughly mixes the solution described above before adding nano particles and anti-microbial solutions step **139**. It will be appreciated that an important feature of the present invention is the surface activation of organic and synthetic fibers is to change the fiber surface charge by introducing cationic groups to the fiber surface through cationization, step **137**. Adsorbed cationic surfactants are used in order to reduce the water wettability. Chemical cationization allows organic fibers to be dyed or infused without salt by chemically modifying cellulosic macromolecules to introduce positively charged sites. This allows the fabric protection (bonding agent) formula to adhere the protector adhesive to attach nano particle size minerals and anti-microbial particles quicker and stronger to fiber and fabric surfaces.

**[0066]** Step **140**, 2<sup>nd</sup> mixing cycle, agitates solution with the fabric for approximately 15 minutes. This allows the nano-size minerals to be evenly distributed onto the fabric/garments and presets the mineral particles to the fibers and/or the fabric surface. The particles will be permanently set to fiber and fabric surfaces when subject to drying process step **143** after extraction of the solution and rinse water baths, step **142**, after mixing step **140**.

**[0067]** Step **141** rinses and softens the fabrics as necessary or desired. It will be appreciated that this rinse step does not wash away the preset particles.

**[0068]** The next step is the hydro extraction step **142**. Hydro extraction process removes the water (the water quantity varies according to the type of fiber) dispersed in the fibers by mechanical action; this process aims at reducing energy consumption and is carried out before the final fabric drying or between the various wet processing stages

**[0069]** The drying cycle, step **143**, dries, or cures, garments at a drying temperature of approximately 110° C.-130° C.; and fabric at a drying time and temperature of approximately 5 min at 130° C. on curing machine or rapid curing process: 45-60 sec at 110-170° C. in stages (Stenter finishing).

**[0070]** The last step in the additive method is inspection and packing step **144**. The optical brightener agent, previously discussed, fluoresces when subjected to an appropriate light source, e.g., a black light, and thus, indirectly shows the distribution or patterned disbursement of the nano particles. If there is inadequate coverage the garments and/or fabrics are reinserted into dye garment machine, step **132**, to add additional nano particles to the uncovered areas.

**[0071]** Referring to FIG. 3 again, there is shown a method flow chart illustrating a process for bonding nano particles to fabrics. The bonding method starts with **131B**. Fabrics loaded into textile STENIER machine as shown in the diagrams and pictures herein. The process of binding/infusing the mineral nano-size particles is similar to the first mentioned process using a garment dye machine. However, the minerals are added at the finishing stage of making fabric for apparel using a Stenter machine to add the chemical bonding solutions with the nano-size minerals onto the fabric by means of an electro-static sprayer that applies the

mixture onto the surface of the fabric on the Stenter Frame with consistent and equally patterned dispersal of the nano-particles.

**[0072]** The fabric to be treated is loaded onto a Stenter machine, step **132B**. Stenter machines are well known in the art and need not be discussed here. Step **134B** premixes the solution described earlier, including the nano particles, bonding solution and defoamer.

**[0073]** The premixed solution is electrostatically sprayed onto the fabric loaded in the Stenter machine. Electrostatic Sprayer delivery device/system. It will be appreciated that the electrostatic process atomizes the solution with high pressure air. The atomized droplets are the electro-magnetically charged to form a spray that electro-statically coats the fabric touch points and grounded fabric surfaces.

**[0074]** The Stenter machine applies heat and drying to the coated fabric to cure the bonding agents for permanently bonding the nano particles to the fabric, step **135B**.

**[0075]** It will be appreciated that the present invention prevents, or minimizes, the wash-out of mineral particles with a pre-determined percentage of components allowing the mineral particles to bond durably to fabrics, fibers, textiles, and other surfaces. The components include mineral particles. An antimicrobial, such as but not limited to SIS 200D™ or PATHOGARD™, an oil and water repellent, such as, but not limited to PHOBOL® CP-R Fabric Protector, a defoamer, such as, STARDEFOAM™ CDF and an Optical Brightener

**[0076]** It should be understood that the foregoing description is only illustrative of the invention. Thus, various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variances that fall within the scope of the appended claims.

1. A method of bonding nano particulates to a plurality of synthetic and non-synthetic fibers, the method comprising:

- providing a plurality of synthetic fibers;
- providing a plurality of non-synthetic fibers;
- desizing the plurality of synthetic and non-synthetic fibers;
- forming said plurality of synthetic and non-synthetic fibers into a fabric;
- imparting a surface charge to a surface of the fabric; and
- adding nano particulates to the surface of the fabric wherein the nano particulates and the plurality of surfaced charged synthetic and non-synthetic fibers form an ionic bond.

2. The method as in claim 1 wherein imparting the surface charge to the surface of the fabric further comprises adding a cationic surfactant to the surface of the fabric.

3. The method as in claim 2 further comprising defoaming the plurality of synthetic and non-synthetic fibers with a defoaming agent.

4. The method as in claim 3 further comprising adding optical white brightener to the plurality of synthetic and non-synthetic fibers; wherein the optical white brightener is used to fluoresce when subjected to an appropriate light source, to make visible the distribution of said nano particles.

5. The method as in claim 1 further comprising adding anti-microbial agents to the plurality of synthetic and non-synthetic fibers.

6. The method as in claim 4 further comprising curing the plurality of synthetic and non-synthetic fibers at approximately 110° C.-130° C.

7. The method as in claim 4 further comprising electrostatically spraying the optical white brightener, the defoaming agent, the cationic surfactant, and the nano particulates onto the surface of the fabric.

8. A method of bonding nano particulates to a surface formed of a plurality of synthetic and non-synthetic fibers, the method comprising:

- providing a plurality of synthetic fibers;
- providing a plurality of non-synthetic fibers;
- desizing the plurality of synthetic and non-synthetic fibers;
- defoaming the plurality of synthetic and non-synthetic fibers with a defoaming agent;
- forming said plurality of synthetic and non-synthetic fibers into a fabric;
- adding microbial quaternary inhibitors to the plurality of synthetic and non-synthetic fibers;
- imparting a surface charge to a surface of the fabric, wherein imparting the surface charge to the surface of the fabric further comprises adding a cationic surfactant to the surface of the fabric; and
- adding thermo reactive Tourmaline nano particulates to the surface of the fabric, wherein the thermo reactive Tourmaline nano particulates and the plurality of surfaced charged synthetic and non-synthetic fibers form an ionic bond.

9. The method as in claim 8 further comprising adding optical white brightener to the plurality of synthetic and non-synthetic fibers

10. The method as in claim 8 further comprising curing the plurality of synthetic and non-synthetic fibers at approximately 110° C.-130° C.

11. The method as in claim 8 further comprising electrostatically spraying the optical white brightener, the defoaming agent, the cationic surfactant, and the thermo reactive nano particulates onto the surface of the fabric.

12. A method of bonding thermo reactive nano particulates to a plurality of synthetic and non-synthetic fibers, the method comprising:

- providing a plurality of synthetic fibers;
- providing a plurality of non-synthetic fibers;
- desizing the plurality of synthetic and non-synthetic fibers;
- defoaming the plurality of synthetic and non-synthetic fibers with a defoaming agent;
- forming said plurality of synthetic and non-synthetic fibers into a fabric;
- imparting a surface charge to a surface of the fabric wherein imparting the surface charge to the surface of the fabric further comprises adding an ionic surfactant to the surface of the fabric;
- adding microbial quaternary inhibitors to the surface of the fabric;
- adding Startex™ OB BSU Solution optical white brightener to the surface of the fabric; and
- adding thermo reactive Tourmaline nano particulates to the surface of the fabric, wherein the thermo reactive Tourmaline nano particulates and the plurality of surfaced charged synthetic and non-synthetic fibers form an ionic bond and wherein Startex™ OB BSU Solution



optical white brightener makes visible that tourmaline and quaternary spike nanoparticles evenly cover the surface of the fabric.

**13.** The method as in claim **12** wherein adding an ionic surfactant to the surface of the fabric comprises adding a cationic surfactant to the surface of the fabric.

**14.** The method as in claim **13** wherein adding an ionic surfactant to the plurality of synthetic and non-synthetic fibers further comprises adding an anionic surfactant to the plurality of synthetic and non-synthetic fibers.

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