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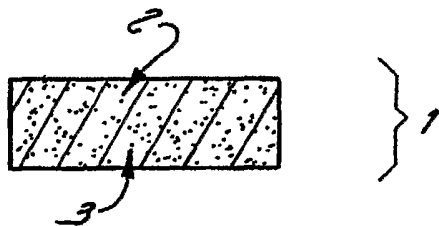
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(54) Title: INSULATION PAPER FACING CONTAINING AN ANTIMICOTIC OF FUNGICIDE AND METHODS OF MAK-
ING AND USING THE SAME



(57) Abstract: The invention relates to the papermaking art and, in par-
ticular, to the manufacture of insulation paper facing having improved
reduction or inhibition in the growth of mold and/or fungus. This inven-
tion also relates to articles of manufacture made from such products such
insulation, construction articles, buildings and the like.

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Insulation Paper Facing Containing an Antimicrobial or Fungicide
and Methods of Making and Using the Same

The present application claims the benefit of priority under 35 USC §119(e) to United States Provisional Patent Application 60/585,757, which is hereby incorporated, in its entirety, herein by reference.

Field of the Invention

The invention relates to the papermaking art and, in particular, to the manufacture of insulation paper facing having improved reduction or inhibition in the growth of mold and/or fungus. This invention also relates to articles of manufacture made from such products such insulation, construction articles, buildings and the like.

Background of the Invention

It is desired to program construction materials for homes and buildings with antimicrobial tendency. That is, the construction industry wishes to increase the resistance of such materials to the growth of microbes including bacteria, virus, mold, mildew, fungus, and the like.

One example of an opportunity to reinforce the antimicrobial tendency of new construction is to render the construction materials, such as insulation materials and the like, for homes, residential buildings, commercial buildings, offices, stores, and industrial buildings with the same antimicrobial tendency.

Insulation materials include, in part, a facing layer, an adhesive layer and an insulation layer. Examples of the same can be found described in US Patent Nos. 6,901,711; 6,357,504; 6,191,057; 5,848,509; 2,913,104; 3,307,306; 3,729,879; and 4,709,523, all of which are hereby incorporated, in their entirety, herein by reference.

Examples of applying antimicrobial chemistries to construction and building components can be found in US Patent Nos. 3,857,934; 3,976,495; and 4,629,645 as well as US Patent Application

Publication Nos. 20040185212, 20040185211, 20040185210, 20040185209, 20040185204, 20020100246, 20030132425 and 20030156974, all of which are hereby incorporated, in their entirety, herein by reference. However, the above-mentioned references appear to focus mostly on antimicrobial compounds as added to construction materials that are not insulation paper facing.

Examples of applying antimicrobial chemistries to cellulose-containing articles can be found in US Patent No. 3,936,339, which is hereby incorporated, in its entirety, herein by reference. However, the articles according to this reference are related to packaging materials.

Examples of applying antimicrobial chemistries to gypsum board can be found in US Patent Application Publication Nos. 20020083671; 20030037502 and 20030170317, all of which are hereby incorporated, in their entirety, herein by reference. All of which pertain to gypsum containing products.

While all of the above examples aid to provide materials with antimicrobial tendency by applying antimicrobial chemistries and compounds to the material and/or components thereof, none sufficiently provide for an insulation paper facing that is acceptable by commercial market standards in a manner that inhibits, retards, and/or resists antimicrobial growth over an acceptable duration of time, nor do they provide for an acceptable method of making and using the same.

Accordingly, there exists a need for insulation paper facing that inhibits, retards, and/or resists antimicrobial growth over an acceptable duration of time so as to provide, in part, construction materials desirable in today's market.

SUMMARY OF THE INVENTION

One aspect of the present invention relates to an insulation paper facing containing a web of cellulose fibers and an antimicrobial compound, e.g. antimicotic or fungicide, where the antimicrobial compound, e.g. antimicotic or fungicide, is approximately dispersed evenly throughout from 100% to 5% of the web, as well as methods of making and using the same. The insulation

paper inhibits, retards, or reduces the growth of mold or fungus on or in the paper substrate. The paper facing may be made by contacting the antimicrobial compound with the fibers prior to a coating step, prior to a size press step, at the wet end, etc. The antimicrobial compound may be approximately evenly distributed throughout the web.

In another aspect of the present invention, the insulation paper facing further contains an adhesive, binder, or mixtures thereof. An embodiment of this invention may be a paper facing containing a first foil layer in contact with a first adhesive layer; the paper substrate in contact with the first adhesive layer; and an oriented strand board layer in contact with the paper layer. An additional embodiment of the present invention may be the paper facing containing a first foil layer in contact with a first adhesive layer; the paper substrate in contact with the first adhesive layer; a second adhesive layer in contact with the paper substrate; a second foil layer in contact with the second adhesive layer; and a foam layer in contact with the second foil layer.

An additional aspect of the invention is an insulation paper facing containing a first layer comprising a web of cellulose fibers and a size-press applied coating layer in contact with at a portion of at least one surface of the first layer, where the coating layer contains an antimicrobial compound (e.g. antimicrobial, fungicide) and where from 0.5 to 100 % of the coating layer interpenetrates the first layer. The antimicrobial or fungicide inhibits, retards, or reduces the growth of mold or fungus on or in the paper facing. In an additional embodiment, the coating layer comprises starch. In a further embodiment, from 25 to 75% of the size-press applied coating layer interpenetrates the first layer.

An additional aspect of the present invention relates to a method of making an insulation paper facing by contacting cellulose fibers with an antimicrobial compound (e.g. antimicrobial or fungicide) during or prior to a papermaking process. One embodiment of the present invention relates to a process where the cellulose fibers are contacted with the antimicrobial compound (e.g. antimicrobial or fungicide) at the wet end of the papermaking process, thin stock, thick stock, machine chest, the headbox, size press, coater, shower, sprayer, steambox, or a combination thereof. If the contacting occurs at the size press and produces a facing comprising a first layer comprising a web of cellulose fibers and a starch based, size-press applied coating layer in contact with at a portion of at least one surface of the first layer so that from 25 to 75% of the starch based, size-press applied coating layer interpenetrates the first layer.

Additional aspects and embodiments of the present invention are described hereinbelow.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: A first schematic cross section of just one exemplified embodiment of the paper substrate that is included in the paper facing of the present invention.

Figure 2: A second schematic cross section of just one exemplified embodiment of the paper substrate that is included in the paper facing of the present invention.

Figure 3: A third schematic cross section of just one exemplified embodiment of the paper substrate that is included in the paper facing of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The inventors of the present technology have discovered an insulation paper facing with antimicrobial tendency by applying antimicrobial chemistries and compounds to the material

and/or components thereof. Further, the insulation paper facing of the present invention inhibits, retards, and/or resists antimicrobial growth over an acceptable duration of time.

The insulation paper facing of the present invention may contain a paper substrate.

The paper substrate of the present invention may contain recycled fibers and/or virgin fibers. Recycled fibers differ from virgin fibers in that the fibers have gone through the drying process several times.

The paper substrate of the present invention may contain from 1 to 100 wt%, preferably from 50 to 100 wt%, most preferably from 80 to 100 wt% of cellulose fibers based upon the total weight of the substrate, including 1, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 and 99 wt%, and including any and all ranges and subranges therein. More preferred amounts of cellulose fibers range from wt%.

Preferably, the sources of the cellulose fibers are from softwood and/or hardwood. The paper substrate of the present invention may contain from 1 to 99 wt%, preferably from 5 to 95 wt%, cellulose fibers originating from softwood species based upon the total amount of cellulose fibers in the paper substrate. This range includes 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 100wt%, including any and all ranges and subranges therein, based upon the total amount of cellulose fibers in the paper substrate.

The paper substrate of the present invention may contain from 1 to 99 wt%, preferably from 5 to 95 wt%, cellulose fibers originating from hardwood species based upon the total amount of cellulose fibers in the paper substrate. This range includes 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 100wt%, including any and all ranges and subranges therein, based upon the total amount of cellulose fibers in the paper substrate.

The preferred ratio of softwood/hardwood is greater than or equal to 50% softwood and less than or equal to 50% hardwood.

Further, the softwood and/or hardwood fibers contained by the paper substrate of the present invention may be modified by physical and/or chemical means. Examples of physical means include, but is not limited to, electromagnetic and mechanical means. Means for electrical modification include, but are not limited to, means involving contacting the fibers with an electromagnetic energy source such as light and/or electrical current. Means for mechanical modification include, but are not limited to, means involving contacting an inanimate object with the fibers. Examples of such inanimate objects include those with sharp and/or dull edges. Such means also involve, for example, cutting, kneading, pounding, impaling, etc means.

Examples of chemical means include, but is not limited to, conventional chemical fiber modification means including crosslinking and precipitation of complexes thereon. Examples of such modification of fibers may be, but is not limited to, those found in the following patents 6,592,717, 6,592,712, 6,582,557, 6,579,415, 6,579,414, 6,506,282, 6,471,824, 6,361,651, 6,146,494, H1,704, 5,731,080, 5,698,688, 5,698,074, 5,667,637, 5,662,773, 5,531,728, 5,443,899, 5,360,420, 5,266,250, 5,209,953, 5,160,789, 5,049,235, 4,986,882, 4,496,427, 4,431,481, 4,174,417, 4,166,894, 4,075,136, and 4,022,965, which are hereby incorporated, in their entirety, herein by reference.

The paper substrate of the present invention may contain an antimicrobial compound.

Antimicrotics, fungicides are examples of antimicrobial compounds. Antimicrobial compounds may retard, inhibit, reduce, and/or prevent the tendency of microbial growth over time on/in a product containing such compounds as compared to that tendency of microbial growth on/in a product not containing the antimicrobial compounds. The antimicrobial compound when incorporated into the paper facing of the present invention preferably retards, inhibits, reduces, and/or prevents microbial growth for a time that is at least 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 75, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 700, 800, 900, 1000% greater than that of a paper facing that does not contain an antimicrobial compound, including all ranges and subranges therein.

Antimicrotic compounds are, in part, mold resistant. Fungicide compounds are, in part, fungus resistant. The antimicrobial compound may have other functions and activities than

provide either mold resistance and/or fungus resistance to a product containing the same.

The antimicrobial compound may also be mildew, bacteria and/or virus resistant. A mold specifically targeted, but meant to be non-limiting, is Black mold as applied to the above-mentioned paper facing of the present invention.

It is preferable for the antimicrobial and/or fungicide to be effective to be able to be applied in aqueous solution and/or suspension at the coater and/or head box and/or size press. Further it is preferable for the antimicrobial and/or fungicide to not be highly toxic to humans.

The antimicrobial and/or fungicide may be water insoluble and/or water soluble, most preferably water insoluble. The antimicrobial and/or fungicide may be volatile and/or non-volatile, most preferably non-volatile. The antimicrobial and/or fungicide may be organic and/or inorganic. The antimicrobial and/or fungicide may be polymeric and/or monomeric.

The antimicrobial and/or fungicide may be multivalent which means that the agent may carry one or more active compounds so as to protect against a wider range of mold, mildew and/or fungus species and to protect from evolving defense mechanisms within each species of mold, mildew and/or fungus.

Any water-soluble salt of pyrrithione having antimicrobial properties is useful as the antimicrobial compound. Pyrrithione is known by several names, including 2 mercaptopyridine-N-oxide; 2-pyridinethiol-1-oxide (CAS Registry No. 1121-31-9); 1-hydroxypyridine-2-thione and 1 hydroxy-2(1H)-pyridinethione (CAS Registry No. 1121-30-8). The sodium derivative, known as sodium pyrrithione (CAS Registry No. 3811-73-2), is one embodiment of this salt that is particularly useful. Pyrrithione salts are commercially available from Arch Chemicals, Inc. of Norwalk, Conn., such as Sodium OMADINE or Zinc OMADINE.

Examples of the antimicrobial compound may include silver-containing compound, zinc-containing compound, an isothiazolone-containing compound, a benzothiazole-containing compound, a triazole-containing compound, an azole-containing compound, a benzimidazol-

containing compound, a nitrile containing compound, alcohol-containing compound, a silane-containing compound, a carboxylic acid-containing compound, a glycol-containing compound, a thiol-containing compound or mixtures thereof

Additional exemplified commercial antimicrobial compounds may include those from Intace including B-6773 and B-350, those from Progressive Coatings VJ series, those from Buckman Labs including Busan 1218, 1420 and 1200WB, those from Troy Corp including Polyphase 641, those from Clariant Corporation, including Sanitized TB 83-85 and Sanitized Brand T 96-21, and those from Bentech LLC including Preservor Coater 36. Others include AgION (silver zeolite) from AgION and Mircroban from Microban International (e.g. Microban additive TZ1, S2470, and PZ2). Further examples include dichloro-octyl-isothiazolone, Tri-n-butyltin oxide, borax, G-4, chlorothalonil, organic fungicides, and silver-based fungicides. Any one or more of these agents would be considered satisfactory as an additive in the process of making paper material. Further commercial products may be those from AEGIS Environments (e.g. AEM 5772 Antimicrobial), from BASF Corporation (e.g. propionic acid), from Bayer (e.g. Metasol TK-100, TK-25), those from Bendiner Technologies, LLC, those from Ondeil-Nalco (e.g. Nalcon 7645 and 7622), and those from Hercules (e.g. RX 8700, RX 3100, and PR 1912). The MSDS's of each and every commercial product mentioned above is hereby incorporated by reference in its entirety.

Still further, examples of the antimicrobial compounds may include silver zeolite, dichloro-octyl-isothiazolone, 4,5-dichloro-2-n-octyl-3(2H)-isothiazolone, 5-chloro-2-methyl-4-isothiazolin-3-one, 1,2-benzothiazol-3(2H)-one, poly[oxyethylene(ethylimino)ethylene dichloride], Tri-n-butyltin oxide, borax, G-4, chlorothalonil, Alkyl-dimethylbenzyl-ammonium saccharinate, dichloropeyl-propyl-dioxolan-methyl-triazole, alpha-chlorophenyl, ethyl-dimethylethyl-triazole-ethanol, benzimidazol, 2-(thiocyanomethylthio)benzothiazole, alpha-2-(4-chlorophenyl)ethyl)-alpha-(1-1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol, (1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]-methyl]-1H-1,2,4-triazole, alkyl dimethylbenzyl ammonium saccharinate, 2-(methoxy-carbamoyl)-benzimidazol, tetrachlorisophthalonitrile, P-[(diiodomethyl) sulfonyl] toluol, methyl alcohol, 3-(trimethoxysilyl) propyldimethyl octadecyl ammonium chloride, chloropropyltrimethylsilane, dimethyl octadecyllamine, propionic acid, 2-

(4-thiazolyl)benzimidazole, 1,2-benzisothiazolin-3-one, 2-N-octyl-4-isthiazolin-3-one, diethylene glycol monoethyl ether, ethylene glycol, propylene glycol, hexylene glycol, tributoxyethyl phosphate, 2-pyridinethio-1-oxide, potassium sorbate, diiodomethyl-p-tolysulfone, citric acid, lemon grass oil, and thiocyanomethythio-benzothiazole.

The antimicrobial compound may be present in the insulation paper facing at amounts from 1 to 5000 ppm dry weight, more preferably, from 100 to 3000 ppm dry weight, most preferably 50 to 1500 ppm dry weight. The amounts of antimicotic and/or fungicide may be 2, 5, 10, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000, 2100, 2200, 2300, 2400, 2500, 2600, 2700, 2800, 2900, 3000, 3200, 3500, 3750, 4000, 4250, 4500, 4750, and 5000 ppm dry weight based upon the total weight of the paper substrate, including all ranges and subranges therein. Higher amounts of such antimicotic and/or fungicide may also prove produce an antibacterial paper material and article therefrom as well. These amount are based upon the total weight of the paper substrate.

The paper substrate of the present invention, when containing the web of cellulose fibers and an antimicrobial compound, may contain them in a manner in which the antimicrobial compound is on the surface of or within from 1 to 100% of the web. The paper substrate may contain the antimicrobial compound on the surface of and/or within 1, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 and 100% of the web, including all ranges and subranges therein.

When the antimicrobial compound is present on at least one surface of the web, it is preferable that the antimicrobial compound also be within 1, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 and 100% of the web, including all ranges and subranges therein.

In another embodiment, it is preferable that, when the antimicrobial compound is within the web, it is approximately dispersed evenly throughout 1, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 and 100% of the web. However, concentration gradients of

the antimicrobial compound may occur within the web as a function of the cross section of the web itself. Such gradients are dependent upon the methodology utilized to make this product. For instance, the concentration of the antimicrobial compound may increase as the distance from a center portion of the cross-section of the web increases. That is, the concentration increases as one approaches the surface of the web. Further, the concentration of the antimicrobial compound may decrease as the distance from a center portion of the cross-section of the web decreases. That is, the concentration decreases as one approaches the surface of the web. Still further, the concentration of the antimicrobial compound is approximately evenly distributed throughout the portion of the web in which it resides. All of the above embodiments may be combined with each other, as well as with an embodiment in which the antimicrobial compound resides on at least one surface of the web.

Figures 1-3 demonstrate different embodiments of the paper substrate **1** in the paper facing of the present invention. Figure 1 demonstrates a paper substrate **1** that has a web of cellulose fibers **3** and a composition containing an antimicrobial compound **2** where the composition containing an antimicrobial compound **2** has minimal interpenetration of the web of cellulose fibers **3**. Such an embodiment may be made, for example, when an antimicrobial compound is coated onto a web of cellulose fibers.

Figure 2 demonstrates a paper substrate **1** that has a web of cellulose fibers **3** and a composition containing an antimicrobial compound **2** where the composition containing an antimicrobial compound **2** interpenetrates the web of cellulose fibers **3**. The interpenetration layer **4** of the paper substrate **1** defines a region in which at least the antimicrobial compound penetrates into and is among the cellulose fibers. The interpenetration layer may be from 1 to 99% of the entire cross section of at least a portion of the paper substrate, including 1, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 99% of the paper substrate, including any and all ranges and subranges therein. Such an embodiment may be made, for example, when an antimicrobial compound is added to the cellulose fibers prior to a coating method and may be combined with a subsequent coating method if required. Addition points may be at the size press, for example.

Figure 3 demonstrates a paper substrate 1 that has a web of cellulose fibers 3 and an antimicrobial compound 2 where the antimicrobial compound 2 is approximately evenly distributed throughout the web of cellulose fibers 3. Such an embodiment may be made, for example, when an antimicrobial compound is added to the cellulose fibers prior to a coating method and may be combined with a subsequent coating method if required. Exemplified addition points may be at the wet end of the paper making process, the thin stock, and the thick stock.

The web of cellulose fibers and the antimicrobial compound may be in a multilayered structure. The thicknesses of such layers may be any thickness commonly utilized in the paper making industry for a paper substrate, a coating layer, or the combination of the two. The layers do not have to be of approximate equal size. One layer may be larger than the other. One preferably embodiment is that the layer of cellulose fibers has a greater thickness than that of any layer containing the antimicrobial compound. The layer containing the cellulose fibers may also contain, in part, the antimicrobial compound.

The density, basis weight and caliper of the web of this invention may vary widely and conventional basis weights, densities and calipers may be employed depending on the paper-based product formed from the web. Paper or paperboard of invention preferably have a final caliper, after calendering of the paper, and any nipping or pressing such as may be associated with subsequent coating of from about 1 mil to about 30 mils although the caliper can be outside of this range if desired. More preferably the caliper is from about 1 mil to about 5 mils, and most preferably from about 1 mil to about 4 mils. The caliper may be 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 25, and 30 mils, including any and all ranges and subranges therebetween. Papers of the invention preferably exhibit basis weights of from about 15 lb/3000ft² to about 300 lb/3000ft², although web basis weight can be outside of this range if desired. More preferably the basis weight is from about 20 lb/3000ft² to about 100 lb/3000ft², and most preferably from about 25 lb/3000ft² to about 45 lb/3000ft². The basis weight may be 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 225, 250, 275, and 300 lb/3000ft², including any and all ranges and subranges therebetween. The final

density of the papers may be calculated by any of the above-mentioned basis weights divided by any of the above-mentioned calipers.

The paper substrate of the present invention containing the web and the antimicrobial compound has the capability to retard, inhibit, reduce, and/or prevent the tendency of microbial growth over time on/in its web containing such compounds as compared to that tendency of microbial growth on/in a product not containing the antimicrobial compound. Further, the paper substrate of the present invention may also bestow such tendency on additional materials of which it may comprise and/or with which it may be in contact. Still further, the paper substrate of the present invention may also bestow this tendency upon any article, building, and/or construction of which it may eventually be a component therein.

The paper facing of the present invention, as well as the above-mentioned additional materials, articles, buildings, and/or constructions of the present invention, may have an antimicrobial tendency that preferably retards, inhibits, reduces, and/or prevents microbial growth for a time that is at least 5% greater than that of a paper facing, additional material, article, building, and/or construction that does not contain an antimicrobial compound. Preferably, such tendency is at least 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 75, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 700, 800, 900, 1000% greater than that of a paper facing, additional material, article, building, and/or construction that does not contain an antimicrobial compound, including all ranges and subranges therein.

The paper substrate's antimicrobial tendency may be measured in part by ASTM standard testing methodologies such as G-21, C1338, and D2020, all of which can be found as published by ASTM and all of which are hereby incorporated, in their entirety, herein by reference.

Textbooks such as those described in the "Handbook for pulp and paper technologists" by G.A. Smook (1992), Angus Wilde Publications, which is hereby incorporated, in its entirety, by reference. Further, G.A. Smook referenced above and references cited therein provide lists of conventional additives that may be contained in the paper substrate, and therefore, the paper facing of the present invention. Such additives may be incorporated into the paper, and therefore,

the paper facing of the present invention in any conventional paper making process according to G.A. Smook referenced above and references cited therein.

The paper substrate of the present invention may also include optional substances including retention aids, sizing agents, binders, fillers, thickeners, and preservatives. Examples of fillers include, but are not limited to; clay, calcium carbonate, calcium sulfate hemihydrate, and calcium sulfate dehydrate. Examples of binders include, but are not limited to, polyvinyl alcohol, polyamide-epichlorohydrin, polychloride emulsion, modified starch such as hydroxyethyl starch, starch, polyacrylamide, modified polyacrylamide, polyol, polyol carbonyl adduct, ethanediol/polyol condensate, polyamide, epichlorohydrin, glyoxal, glyoxal urea, ethanediol, aliphatic polyisocyanate, isocyanate, 1,6 hexamethylene diisocyanate, diisocyanate, polyisocyanate, polyester, polyester resin, polyacrylate, polyacrylate resin, acrylate, carboxymethyl cellulose, urea, sodium nitrate, and methacrylate. Other optional substances include, but are not limited to silicas such as colloids and/or sols. Examples of silicas include, but are not limited to, sodium silicate and/or borosilicates. Another example of optional substances is solvents including but not limited to water.

The paper substrate of the insulation paper facing of the present invention may contain retention aids selected from the group consisting of coagulation agents, flocculation agents, and entrapment agents dispersed within the bulk and porosity enhancing additives cellulosic fibers.

Retention aids for the bulk-enhancing additives to retain a significant percentage of the additive in the middle of the paperboard and not in the periphery. Suitable retention aids function through coagulation, flocculation, or entrapment of the bulk additive. Coagulation comprises a precipitation of initially dispersed colloidal particles. This precipitation is suitably accomplished by charge neutralization or formation of high charge density patches on the particle surfaces. Since natural particles such as fines, fibers, clays, etc., are anionic, coagulation is advantageously accomplished by adding cationic materials to the overall system. Such selected cationic materials suitably have a high charge to mass ratio. Suitable coagulants include inorganic salts such as alum or aluminum chloride and their polymerization products (e.g. PAC or poly aluminum chloride or synthetic polymers); poly(diallyldimethyl ammonium chloride) (i.e., DADMAC);

poly(dimethylamine)-co-epichlorohydrin; polyethylenimine; poly(3-butenyltrimethyl ammoniumchloride); poly(4-ethenylbenzyltrimethylammonium chloride); poly(2,3-epoxypropyltrimethylammonium chloride); poly(5-isoprenyltrimethylammonium chloride); and poly(acryloyloxyethyltrimethylammonium chloride). Other suitable cationic compounds having a high charge to mass ratio include all polysulfonium compounds, such as, for example the polymer made from the adduct of 2-chloromethyl; 1,3-butadiene and a dialkylsulfide, all polyamines made by the reaction of amines such as, for example, ethylenediamine, diethylenetriamine, triethylenetetraamine or various dialkylamines, with bis-halo, bis-epoxy, or chlorohydrin compounds such as, for example, 1-2 dichloroethane, 1,5-diepoxihexane, or epichlorohydrin, all polymers of guanidine such as, for example, the product of guanidine and formaldehyde with or without polyamines. The preferred coagulant is poly(diallyldimethyl ammonium chloride) (i.e., DADMAC) having a molecular weight of about ninety thousand to two hundred thousand and polyethylenimine having a molecular weight of about six hundred to 5 million. The molecular weights of all polymers and copolymers herein this application are based on a weight average molecular weight commonly used to measure molecular weights of polymeric systems.

Another advantageous retention system suitable for the manufacture of the paper substrate of this invention is flocculation. This is basically the bridging or networking of particles through oppositely charged high molecular weight macromolecules. Alternatively, the bridging is accomplished by employing dual polymer systems. Macromolecules useful for the single additive approach are cationic starches (both amylase and amylopectin), cationic polyacrylamide such as for example, poly(acrylamide)-co-diallyldimethyl ammonium chloride; poly(acrylamide)-co-acryloyloxyethyl trimethylammonium chloride, cationic gums, chitosan, and cationic polyacrylates. Natural macromolecules such as, for example, starches and gums, are rendered cationic usually by treating them with 2,3-epoxypropyltrimethylammonium chloride, but other compounds can be used such as, for example, 2-chloroethyl-dialkylamine, acryloyloxyethylalkyl ammonium chloride, acrylamidoethyltrialkylammonium chloride, etc. Dual additives useful for the dual polymer approach are any of those compounds which function as coagulants plus a high molecular weight anionic macromolecule such as, for example, anionic starches, CMC (carboxymethylcellulose), anionic gums, anionic polyacrylamides (e.g., poly(acrylamide)-co-acrylic acid), or a finely dispersed colloidal particle (e.g., colloidal silica,

colloidal alumina, bentonite clay, or polymer micro particles marketed by Cytec Industries as Polyflex). Natural macromolecules such as, for example, cellulose, starch and gums are typically rendered anionic by treating them with chloroacetic acid, but other methods such as phosphorylation can be employed. Suitable flocculation agents are nitrogen containing organic polymers having a molecular weight of about one hundred thousand to thirty million. The preferred polymers have a molecular weight of about ten to twenty million. The most preferred have a molecular weight of about twelve to eighteen million. Suitable high molecular weight polymers are polyacrylamides, anionic acrylamide-acrylate polymers, cationic acrylamide copolymers having a molecular weight of about five hundred thousand to thirty million and polyethylenimenes having molecular weights in the range of about five hundred thousand to two million.

The paper substrate of the insulation paper facing of the present invention may contain high molecular weight anionic polyacrylamides, or high molecular weight polyethyleneoxides (PEO). Alternatively, molecular nets are formed in the network by the reaction of dual additives such as, for example, PEO and a phenolic resin.

The paper substrate of the insulation paper facing of the present invention may contain from 0.001 to 20 wt% of the optional substances based on the total weight of the substrate, preferably from 0.01 to 10 wt %, most preferably 0.1 to 5.0wt%, of each of at least one of the optional substances. This range includes 0.001, 0.002, 0.005, 0.006, 0.008, 0.01, 0.02, 0.03, 0.04, 0.05, 0.1, 0.2, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 4, 5, 6, 8, 10, 12, 14, 15, 16, 18, and 20wt% based on the total weight of the substrate, including any and all ranges and subranges therein.

The optional substances may be dispersed throughout the cross section of the paper substrate or may be more concentrated within the interior of the cross section of the paper substrate. Further, other optional substances such as binders for example may be concentrated more highly towards the outer surfaces of the cross section of the paper substrate. More specifically, a majority percentage of optional substances such as binders may preferably be located at a distance from the outside surface of the substrate that is equal to or less than 25%, more preferably 10%, of the total thickness of the substrate.

An example of a binder is polyvinyl alcohol in combination with, for example, starch or alone such as polyvinyl alcohol having a %hydrolysis ranging from 100% to 75%. The % hydrolysis of the polyvinyl alcohol may be 75, 76, 78, 80, 82, 84, 85, 86, 88, 90, 92, 94, 95, 96, 98, and 100%hydrolysis, including any and all ranges and subranges therein.

The paper substrate of the present invention may then contain PVOH at a wt% of from 0.05wt% to 20wt% based on the total weight of the substrate. This range includes 0.001, 0.002, 0.005, 0.006, 0.008, 0.01, 0.02, 0.03, 0.04, 0.05, 0.1, 0.2, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 4, 5, 6, 8, 10, 12, 14, 15, 16, 18, and 20wt% based on the total weight of the substrate, including any and all ranges and subranges therein.

The paper substrate the present invention may contain a surface sizing agent such as starch and/or modified and/or functional equivalents thereof at a wt% of from 0.05wt% to 20wt%, preferably from 5 to 15 wt% based on the total weight of the substrate. The wt% of starch contained by the substrate may be 0.05, 0.1, 0.2, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 4, 5, 6, 8, 10, 12, 14, 15, 16, 18, and 20wt% based on the total weight of the substrate, including any and all ranges and subranges therein. Examples of modified starches include, for example, oxidized, cationic, ethylated, hydroethoxylated, etc. Examples of functional equivalents are, but not limited to, polyvinyl alcohol, polyvinylamine, alginate, carboxymethyl cellulose, etc.

Further, the starch may be of any type, including but not limited to oxidized, ethylated, cationic and pearl, and is preferably used in aqueous solution. Illustrative of useful starches for the practice of this preferred embodiment of the invention are naturally occurring carbohydrates synthesized in corn, tapioca, potato and other plants by polymerization of dextrose units. All such starches and modified forms thereof such as starch acetates, starch esters, starch ethers, starch phosphates, starch xanthates, anionic starches, cationic starches and the like which can be derived by reacting the starch with a suitable chemical or enzymatic reagent can be used in the practice of this invention.

Useful starches may be prepared by known techniques or obtained from commercial sources. For example, the suitable starches include PG-280 from Penford Products, SLS-280 from St. Lawrence Starch, the cationic starch CatoSize 270 from National Starch and the hydroxypropyl No. 02382 from Poly Sciences, Inc.

Preferred starches for use in the practice of this invention are modified starches. More preferred starches are cationic modified or non-ionic starches such as CatoSize 270 and KoFilm 280 (all from National Starch) and chemically modified starches such as PG-280 ethylated starches and AP Pearl starches. More preferred starches for use in the practice of this invention are cationic starches and chemically modified starches.

In addition to the starch, small amounts of other additives may be present as well in the size composition. These include without limitation dispersants, fluorescent dyes, surfactants, deforming agents, preservatives, pigments, binders, pH control agents, coating releasing agents, optical brighteners, defoamers and the like. Such additives may include any and all of the above-mentioned optional substances, or combinations thereof.

The paper substate of the present invention may be further combined with additional components in a manner that makes it useful as a paper facing for insulation which, in turn, may be utilized as a component and/or in a component for constructions such as homes, residential buildings, commercial buildings, offices, stores, and industrial buildings. Accordingly, insulation paper facing as well as the above-mentioned constructions are also aspects of the present invention.

The insulation paper facing may contain, in addition to the above-mentioned paper substate of the present invention at least one adhesive layer, at least one foil layer, or at least one insulation layer, or combinations of such layers. These functional layers may also be combined into multifunctional layers, including any layer containing the paper substrate of the present invention.

The insulation paper facing of the present invention may contain at least one adhesive.

Examples of the adhesive include any conventional adhesive and/or laminate known to the skilled artisan which may contain, in part, polyolefin, asphalt, organic polymer, ethylene-containing polymer, ethylene-containing co-polymer, polyethylene-containing polymer, a laminate, and polyethylene-containing co-polymer, low density polyethylene (LDPE), high density polyethylene (HDPE), and polyethylene. Preferably, the adhesive is a laminate and/or contains asphalt, LDPE, HDPE, and/or polyethylene. The adhesive may be a separate layer that is in contact with the paper substrate and/or interpenetrated with the paper substrate.

The insulation paper facing of the present invention may contain at least one foil. Examples of the foil include any conventional foil known to the skilled artisan which may contain a metal. Preferably, the metal contains aluminum. The foil may be a separate layer that is in contact with the paper substrate and/or the adhesive, and/or interpenetrated with the paper substrate and/or the adhesive in any combination.

The insulation paper facing of the present invention may contain and/or contact at least one insulation layer. Examples of the insulation layer may include any conventional insulation known to the skilled artisan. The insulation may contain glass, fiberglass, a urethane-containing compound, polyurethane, cotton fiber, styrene-containing compound, phenolic-containing compound, ethylene-containing compound, imide-containing compound, vinyl-containing compound, polystyrene, polyethylene, polyimide, polyvinyl, copolymers thereof, and mixtures thereof or mixtures thereof. Preferably, the insulation contains a glass, fiberglass, a urethane-containing compound and/or polyurethane. The insulation may be a separate layer that is in contact with the paper substrate and/or the adhesive and/or the foil, and/or interpenetrated therewith the paper substrate and/or the adhesive and/or the foil in any combination.

In one embodiment, the insulation may be a foam. Examples of the foam may include any conventional foams known to the skilled artisan capable of being utilized as insulation materials. The foam may contain a urethane-containing compound, styrene-containing compound, phenolic-containing compound, ethylene-containing compound, imide-containing compound, vinyl-containing compound, polystyrene, polyethylene, polyimide, polyvinyl, copolymers thereof, and mixtures thereof. Preferably the foam may contain a urethane-

containing compound and/or polyurethane. The foam may be a separate layer that is in contact with the paper substrate and/or the adhesive and/or the foil, and/or interpenetrated therewith the paper substrate and/or the adhesive and/or the foil in any combination.

In another embodiment the paper facing of the present invention may contain and/or contact an oriented strand board. The oriented strand board may contain a web and/or board of cellulose fiber that may be in the form of chips and/or a wood-like substance. Further, the OSB may be a wood-containing chip and/or particle. The wood-like substance may contain anything that is commonly known to make wood substitutes and/or wood-like molded articles. The oriented strand board may be in contact with and/or interpenetrated with at least one of the above-mentioned paper substrate, adhesive, insulation, foam and/or foil. The oriented strand board (OSB) may be any conventional OSB known to one skilled in the art so long as it is incorporated into and/or onto the paper facing of the present invention. Examples of OSB's commonly known in the art may be found in United States Patents: 6,913,785; 6,908,677; 6,902,767; 6,901,715; 6,886,618; 6,885,198; 6,881,817; 6,875,504; 6,869,901; 6,869,661; 6,867,421; 6,861,131; 6,854,230; 6,854,228; 6,852,765; 6,852,386; 6,849,322; 6,846,446; 6,844,420; 6,841,101; 6,821,631; 6,818,317; 6,811,731; 6,803,091; 6,800,352; 6,794,449; 6,779,646; 6,773,791; and 6,772,572, as well as references cited therein, all of which are hereby incorporated, in their entirety, herein by reference.

In a preferred embodiment, a paper facing of the present invention contains a first foil layer in contact with a first adhesive layer, a paper substrate in contact with the first adhesive layer, and an oriented strand board layer in contact with the paper layer. These layers may be separate and/or interpenetrated. Of course, additional layers may be added to this embodiment.

In an additional preferred embodiment, a paper facing of the present invention contains a first foil layer in contact with a first adhesive layer, a paper substrate in contact with the first adhesive layer, a second adhesive layer in contact with the paper substrate, a second foil layer in contact with the second adhesive layer and a foam layer in contact with the second foil layer. These layers may be separate and/or interpenetrated. Of course, additional layers may be added to this embodiment.

In yet another preferred embodiment, a paper facing of thereof the present invention contains a paper substrate in contact with an adhesive layer, and an insulation layer in contact with the adhesive layer. These layers may be separate and/or interpenetrated. Of course, additional layers may be added to this embodiment.

The paper substrate may be made by contacting the antimicrobial compound with the cellulose fibers consecutively and/or simultaneously. Still further, the contacting may occur at acceptable concentration levels that provide the paper substrate of the present invention to contain any of the above-mentioned amounts of cellulose and antimicrobial compound of the present invention isolated or in any combination thereof. More specifically, the paper substrate of the present application may be made by adding an amount that is from 1.5 to 150 times that of the amount of antimicrobial compound that is to be retained within the paper substrate based upon dry weight of the paper substrate with the cellulose fibers. This amount may be 1.5, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, and 125 times that of the amount of antimicrobial compound that is to be retained within the paper substrate based upon dry weight thereof with the cellulose fibers, including any and all ranges and subranges therein. In accordance with the present invention, the contacting may occur so that from 0.1 to 100% of the amount of antimicrobial added to the cellulose fibers based upon dry weight of the paper substrate. The amount retained may be 0.1, 0.2, 0.5, 1, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 and 100% of the antimicrobial compound added to the cellulose fibers is retained in the paper substrate, including any and all ranges and subranges therein.

The contacting of the antimicrobial compound with the cellulose fibers may occur anytime in the papermaking process including, but not limited to the wet end, thick stock, thin stock, head box, size press and coater with the preferred addition point being at the thin stock. Further addition points include machine chest, stuff box, and suction of the fan pump.

The paper substrate may be made by contacting further optional substances with the cellulose fibers as well. The contacting may occur anytime in the papermaking process including, but not limited to the thick stock, thin stock, head box, size press, water box, and coater. Further

addition points include machine chest, stuff box, and suction of the fan pump. The cellulose fibers, antimicrobial compound, and/or optional/additional components may be contacted serially, consecutively, and/or simultaneously in any combination with each other. The cellulose fibers and antimicrobial compound may be pre-mixed in any combination before addition to or during the paper-making process.

The paper substrate may be pressed in a press section containing one or more nips. However, any pressing means commonly known in the art of papermaking may be utilized. The nips may be, but is not limited to, single felted, double felted, roll, and extended nip in the presses. However, any nip commonly known in the art of papermaking may be utilized.

The paper substrate may be dried in a drying section. Any drying means commonly known in the art of papermaking may be utilized. The drying section may include and contain a drying can, cylinder drying, Condebelt drying, IR, or other drying means and mechanisms known in the art. The paper substrate may be dried so as to contain any selected amount of water. Preferably, the substrate is dried to contain less than or equal to 10% water.

The paper substrate may be passed through a size press, where any sizing means commonly known in the art of papermaking is acceptable. The size press, for example, may be a puddle mode size press (e.g. inclined, vertical, horizontal) or metered size press (e.g. blade metered, rod metered). At the size press, sizing agents such as binders may be contacted with the substrate. Optionally these same sizing agents may be added at the wet end of the papermaking process as needed. After sizing, the paper substrate may or may not be dried again according to the above-mentioned exemplified means and other commonly known drying means in the art of papermaking. The paper substrate may be dried so as to contain any selected amount of water. Preferably, the substrate is dried to contain less than or equal to 10% water.

The paper substrate may be calendered by any commonly known calendaring means in the art of papermaking. More specifically, one could utilize, for example, wet stack calendering, dry stack calendering, steel nip calendaring, hot soft calendaring or extended nip calendering, etc.

The paper board and/or substrate of the present invention may also contain at least one coating layer, including two coating layers and a plurality thereof. The coating layer may be applied to at least one surface of the paper board and/or substrate, including two surfaces. Further, the coating layer may penetrate the paper board and/or substrate. The coating layer may contain a binder. Further the coating layer may also optionally contain a pigment. Other optional ingredients of the coating layer are surfactants, dispersion aids, and other conventional additives for printing compositions.

The coating layer may contain a coating polymer and/or copolymer which may be branched and/or crosslinked. Polymers and copolymers suitable for this purpose are polymers having a melting point below 270 °C. and a glass transition temperature (T_g) in the range of -150 to +120 °C. The polymers and copolymers contain carbon and/or heteroatoms. Examples of suitable polymers may be polyolefins such as polyethylene and polypropylene, nitrocellulose, polyethylene terephthalate, Saran and styrene acrylic acid copolymers. Representative coating polymers include methyl cellulose, carboxymethyl cellulose acetate copolymer, vinyl acetate copolymer, styrene butadiene copolymer, and styrene-acrylic copolymer. Any standard paper board and/or substrate coating composition may be utilized such as those compositions and methods discussed in U.S. Patent No. 6,379,497, which is hereby incorporated, in its entirety, herein by reference.

The coating layer may include a plurality of layers or a single layer having any conventional thickness as needed and produced by standard methods, especially printing methods. For example, the coating layer may contain a basecoat layer and a topcoat layer. The basecoat layer may, for example, contain low density thermoplastic particles and optionally a first binder. The topcoat layer may, for example, contain at least one pigment and optionally a second binder which may or may not be a different binder than the first. The particles of the basecoat layer and the at least one pigment of the topcoat layer may be dispersed in their respective binders.

The invention can be prepared using known conventional techniques. Methods and apparatuses for forming and applying a coating formulation to a paper substrate are well known

in the paper and paperboard art. See for example, G.A. Smook referenced above and references cited therein all of which is hereby incorporated by reference. All such known methods can be used in the practice of this invention and will not be described in detail. For example, the mixture of essential pigments, polymeric or copolymeric binders and optional components can be dissolved or dispersed in an appropriate liquid medium, preferably water.

Any and all additional methodologies of making a paper substrate may be utilized as found in conventional paper making arts such as that found in G.A. Smook referenced above and references cited therein, all of which is hereby incorporated by reference, so long as the antimicrobial compound is contacted with the cellulose fiber.

The paper facing of the present invention may be made by conventional methods of making paper facing.

The present invention is explained in more detail with the aid of the following embodiment example which is not intended to limit the scope of the present invention in any manner.

EXAMPLES

Example 1

A paper facing paper substrate was made by pre-mixing 100ppm of an active ingredient (4,5-dichloro-2-n-octyl-4-isothiazolin-3-one) based upon dry weight tons with cellulose fibers during the paper making process.

The antimicrobial tendency of the paper substrate was tested using ASTM methods D 2020A. The results demonstrated that the paper substrate was resistant to *Aspergillus niger*,

Aspergillus terreus, and *Chaetomium globosum* after two (2 weeks) by demonstrating no growth of such organisms and/or any other organisms during such time.

The antimicrobial tendency of the paper substrate was tested using ASTM C-1338-00. The results demonstrated that the paper substrate was resistant to *Aspergillus niger*, *Aspergillus versicolor*, *Chaetomium globosum*, *Penicillium funiculosum*, and *Aspergillus flavus* after 7 days by demonstrating no growth of such organisms and/or any other organisms during such time.

The antimicrobial tendency of the paper substrate was tested using ASTM G 21-96. The results demonstrated that the paper substrate was resistant to *Aspergillus niger*, *Penicillium pinophilum* 14, *Chaetomium globosum*, *Gliocladium virens*, and *Aureobasidium pullulans* after 28 days by demonstrating no growth of such organisms and/or any other organisms during such time.

Example 2

A paper facing was made by adding standard asphalt to the paper facing paper substrate of Example 1. Then, the resultant paper facing was heated and fiberglass was applied thereto so as to simulate the process of making a paper facing insulation containing the paper substrate of Example 1, asphalt and fiberglass insulation. Both standard asphalt and asphalt treated with an antimicrobial compound as utilized in separate embodiments. The paper facings were tested using ASTM methods D 2020A and G 21-96.

After 7 days the paper facing of Example 2 containing standard asphalt had no growth on either the paper substrate and/or the asphalt as measured according to both the D 2020A and G 21-96 tests. After 14 days, the paper facing of Example 2 containing standard asphalt had no growth on the paper substrate according to the D 2020A test, but had heavy growth on the asphalt according to this test. After 14 days, the paper facing of Example 2 containing standard asphalt had slight growth according to the G 21-96 test. After 21 days, the paper facing of Example 2 containing standard asphalt had moderate growth according to the G 21-96 test. After 28 days, the paper facing of Example 2 containing standard asphalt had heavy growth according to the G 21-96 test.

After 7 days the paper facing of Example 2 containing the treated asphalt had no growth on either the paper substrate and/or the asphalt as measured according to both the D 2020A and G 21-96 tests. After 14 days, the paper facing of Example 2 containing treated asphalt had no growth on the paper substrate, nor the asphalt according to the D 2020A test. After 14 days, the paper facing of Example 2 containing treated asphalt had no growth according to the G 21-96 test. After 21 days, the paper facing of Example 2 containing treated asphalt had slight growth according to the G 21-96 test. After 28 days, the paper facing of Example 2 containing treated asphalt had moderate growth according to the G 21-96 test.

Comparative Example 1

A paper facing containing a paper substrate, standard asphalt, and fiberglass insulation was made in parallel according to that process outlined in Example 2 except that the paper substrate did not contain any antimicrobial compound at all.

The paper facing of Comparative Example 1 had moderate growth everywhere after 7 days and heavy growth everywhere after 14 days according to the D 2020A test. Further the paper facing of Comparative Example 1 had moderate growth, heavy growth, heavy growth, and heavy growth everywhere after 7, 14, 21, and 28 days, respectively, according to the G 21-96 test.

As used throughout, ranges are used as a short hand for describing each and every value that is within the range, including all subranges therein.

Numerous modifications and variations on the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the accompanying claims, the invention may be practiced otherwise than as specifically described herein.

All of the references, as well as their cited references, cited herein are hereby incorporated by reference with respect to relative portions related to the subject matter of the present invention and all of its embodiments

WHAT IS CLAIMED IS:

- 1) An insulation paper facing, comprising
a web of cellulose fibers;
an antimicrobial or fungicide, wherein said antimicrobial is approximately dispersed evenly throughout from 100% to 5% of the web.
- 2) The insulation paper facing according to Claim 1, wherein said antimicrobial or fungicide inhibits, retards, or reduces the growth of mold or fungus on or in the paper substrate.
- 3) The insulation paper facing according to Claim 1, wherein from 1 to 5000 ppm dry weight of the antimicrobial or fungicide is approximately dispersed evenly throughout the web based upon the total weight of the paper substrate.
- 4) The insulation paper facing according to Claim 1, wherein from 1 to 500 ppm dry weight of the antimicrobial or fungicide is approximately dispersed evenly throughout the web based upon the total weight of the paper substrate.
- 5) The insulation paper facing according to Claim 1, wherein from 5 to 200 ppm dry weight of the antimicrobial or fungicide is approximately dispersed evenly throughout the web based upon the total weight of the paper substrate.

- 6) The insulation paper facing according to Claim 1, wherein the antimicrobial or fungicide is nonvolatile.
- 7) The insulation paper facing according to Claim 1, wherein the antimicrobial or fungicide is inorganic, organic, or mixtures thereof.
- 8) The insulation paper facing according to Claim 1, wherein the antimicrobial or fungicide comprises silver, zinc, an isothiazolone-containing compound, a benzothiazole-containing compound, a triazole-containing compound, an azole-containing compound, a benzimidazole-containing compound, a nitrile containing compound, alcohol-containing compound, a silane-containing compound, a carboxylic acid-containing compound, a glycol-containing compound, a thiol-containing compound, or mixtures thereof.
- 9) The insulation paper facing according to Claim 1, wherein the antimicrobial or fungicide is at least one member selected from the group consisting of silver zeolite, dichloro-octyl-isothiazolone, 4,5-dichloro-2-n-octyl-3(2H)-isothiazolone, Tri-n-butyltin oxide, borax, G-4, chlorothalonil, Alkyl-dimethylbenzyl-ammonium saccharinate, dichloropropyl-propyl-dioxolan-methyl-triazole, alpha-chlorophenyl, ethyl-dimethylethyl-triazole-ethanol, benzimidazole, 2-(thiocyanomethylthio)benzothiazole, alpha-2-(4-chlorophenyl)ethyl-alpha-(1-(1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol, (1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]-methyl]-1H-1,2,4-triazole, alkyl dimethylbenzyl ammonium

saccharinate, 2-(methoxy-carbamoyl)-benzimidazol, tetrachlorisophthalonitrile, P-[(diiodomethyl) sulfonyl] toluol, methyl alcohol, 3-(trimethoxysilyl) propyldimethyl octadecyl ammonium chloride, chloropropyltrimethylsilane, dimethyl octadecyllamine, propionic acid, 2-(4-thiazolyl)benzimidazole, 1,2-benzisothiazolin-3-one, 2-N-octyl-4-isthiazolin-3-one, diethylene glycol monoethyl ether, ethylene glycol, propylene glycol, hexylene glycol, tributoxyethyl phosphate, 2-pyridinethio-1-oxide, potassium sorbate, diiodomethyl-p-tolysulfone, and thiocyanomethythio-benzothiazole.

- 10) The insulation paper facing according to Claim 1, further comprising an adhesive, binder, or mixtures thereof.
- 11) The insulation paper facing according to Claim 1, further comprising at least one adhesive layer in contact with a portion of at least one surface of the web of cellulose fibers.
- 12) The insulation paper facing according to Claim 11, wherein at least one adhesive layer comprises at least one member selected from the group comprising asphalt, organic polymer, ethylene-containing polymer, ethylene-containing co-polymer, polyethylene-containing polymer, a laminate, and polyethylene-containing co-polymer.

- 13) The insulation paper facing according to Claim 11, further comprising at least one foil layer comprising a metal.
- 14) The insulation paper facing according to Claim 13, wherein the at least one foil layer is in contact with the adhesive layer, the paper substrate, or both.
- 15) The paper facing according to Claim 13, further comprising at least one foam layer comprising a urethane-containing compound, styrene-containing compound, phenolic-containing compound, ethylene-containing compound, imide-containing compound, vinyl-containing compound, polystyrene, polyethylene, polyimide, polyvinyl, copolymers thereof, and mixtures thereof.
- 16) The paper facing according to Claim 13, further comprising at least one foam layer comprising a polyurethane, polystyrene, polyethylene, polyimide, polyvinyl, urethane-containing copolymer, styrene-containing copolymer, ethylene-containing copolymer, imide-containing copolymer, and vinyl-containing copolymer.
- 17) The paper facing according to Claim 16, wherein the at least one foam layer is in contact with the adhesive layer, the foil layer, the paper substrate, or combinations thereof.
- 18) The paper facing according to Claim 17, wherein the facing comprises a first foil layer in contact with a first adhesive layer;

the paper substrate in contact with the first adhesive layer; and
an oriented strand board layer in contact with the paper layer.

- 19) The paper facing according to Claim 17, wherein the facing comprises
a first foil layer in contact with a first adhesive layer;
the paper substrate in contact with the first adhesive layer;
a second adhesive layer in contact with the paper substrate;
a second foil layer in contact with the second adhesive layer; and
a foam layer in contact with the second foil layer.
- 20) The insulation paper facing according to Claim 11, further comprising an insulation layer that is in contact with a portion of at least one surface of the adhesive layer.
- 21) The insulation paper facing according to Claim 20, wherein the insulation layer comprises glass, fiberglass, a urethane-containing compound, polyurethane, cotton fiber, styrene-containing compound, phenolic-containing compound, ethylene-containing compound, imide-containing compound, vinyl-containing compound, polystyrene, polyethylene, polyimide, polyvinyl, copolymers thereof, and mixtures thereof or mixtures thereof.
- 22) The insulation paper facing according to Claim 1, wherein the antimicrobial or fungicide is approximately evenly distributed throughout from 25 to 75% of the cellulose web.

- 23) An insulation paper facing, comprising
- a first layer comprising a web of cellulose fibers; and
- a size-press applied coating layer in contact with at a portion of at least one surface of the first layer, wherein the coating layer comprises an antimicrobial, fungicide, or combination thereof and wherein the from 0.5 to 100 % of the coating layer interpenetrates the first layer.
- 24) The insulation paper facing according to Claim 23, wherein said antimicrobial or fungicide inhibits, retards, or reduces the growth of mold or fungus on or in the paper facing.
- 25) The insulation paper facing according to Claim 23, wherein from 1 to 5000 ppm dry weight of the antimicrobial or fungicide is approximately dispersed evenly throughout the web based upon the total weight of the paper substrate.
- 26) The insulation paper facing according to Claim 23, wherein from 1 to 500 ppm dry weight of the antimicrobial or fungicide is approximately dispersed evenly throughout the web based upon the total weight of the paper substrate.
- 27) The insulation paper facing according to Claim 23, wherein from 5 to 200 ppm dry weight of the antimicrobial or fungicide is approximately dispersed evenly throughout the web based upon the total weight of the paper substrate.

- 28) The insulation paper facing according to Claim 23, wherein the antimicrobial or fungicide is nonvolatile.
- 29) The insulation paper facing according to Claim 23, wherein the antimicrobial or fungicide is inorganic, organic, or mixtures thereof.
- 30) The insulation paper facing according to Claim 23, wherein the antimicrobial or fungicide comprises silver, zinc, an isothiazolone-containing compound, a benzothiazole-containing compound, a triazole-containing compound, an azole-containing compound, a benzimidazole-containing compound, a nitrile containing compound, alcohol-containing compound, a silane-containing compound, a carboxylic acid-containing compound, a glycol-containing compound, a thiol-containing compound or mixtures thereof.
- 31) The insulation paper facing according to Claim 23, wherein the antimicrobial or fungicide is at least one member selected from the group consisting of silver zeolite, dichloro-octyl-isothiazolone, 4,5-dichloro-2-n-octyl-3(2H)-isothiazolone, Tri-n-butyltin oxide, borax, G-4, chlorothalonil, Alkyl-dimethylbenzyl-ammonium saccharinate, dichloropropyl-propyl-dioxolan-methyl-triazole, alpha-chlorophenyl, ethyl-dimethylethyl-triazole-ethanol, benzimidazole, 2-(thiocyanomethylthio)benzothiazole, alpha-2-(4-chlorophenyl)ethyl-alpha-(1-1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol, (1-[[2-(2,4-dichlorophenyl)-4-propyl-

1,3-dioxolan-2-yl]-methyl]-1H-1,2,4-triazole, alkyl dimethylbenzyl ammonium saccharinate, 2-(methoxy-carbamoyl)-benzimidazol, tetrachlorisophthalonitrile, P-[(diiodomethyl) sulfonyl] toluol, methyl alcohol, 3-(trimethoxysilyl) propyldimethyl octadecyl ammonium chloride, chloropropyltrimethylsilane, dimethyl octadecyllamine, propionic acid, 2-(4-thiazolyl)benzimidazole, 1,2-benzisothiazolin-3-one, 2-N-octyl-4-isthiazolin-3-one, diethylene glycol monoethyl ether, ethylene glycol, propylene glycol, hexylene glycol, tributoxyethyl phosphate, 2-pyridinethio-1-oxide, potassium sorbate, diiodomethyl-p-tolysulfone, and thiocyanomethylthio-benzothiazole.

- 32) The insulation paper facing according to Claim 23, wherein the coating layer comprises starch.
- 33) The insulation paper facing according to Claim 23, wherein from 25 to 75% of the starch based, size-press applied coating layer interpenetrates the first layer.
- 34) The insulation paper facing according to Claim 23, further comprising an adhesive layer in contact with a portion of at least one surface of the first layer, coating layer, or both.
- 35) The insulation paper facing according to Claim 34, wherein the adhesive layer comprises at least one member selected from the group comprising asphalt, organic polymer, ethylene-containing polymer, ethylene-containing co-polymer, polyethylene-containing polymer, and polyethylene-containing copolymer.

- 36) The insulation paper facing according to Claim 34, further comprising an insulation layer that is in contact with a portion of at least one surface of the adhesive layer.
- 37) The insulation paper facing according to Claim 36, wherein the insulation layer comprises glass, fiberglass, a urethane-containing compound, polyurethane, cotton fiber, styrene-containing compound, phenolic-containing compound, ethylene-containing compound, imide-containing compound, vinyl-containing compound, polystyrene, polyethylene, polyimide, polyvinyl, copolymers thereof, and mixtures thereof or mixtures thereof.
- 38) A method of making an insulation paper facing, comprising contacting cellulose fibers with an antimicrobial or fungicide during or prior to a papermaking process.
- 39) The method according to Claim 38, wherein the cellulose fibers are contacted with the antimicrobial or fungicide at the wet end of the papermaking process, thin stock, thick stock, machine chest, the headbox, size press, coater, shower, sprayer, steambox, or a combination thereof.
- 40) The method according to Claim 39, wherein the contacting occurs at the size press and produces a facing comprising a first layer comprising a web of cellulose fibers and a starch based, size-press applied coating layer in contact with at a portion of at

least one surface of the first layer so that from 25 to 75% of the starch based, size-press applied coating layer interpenetrates the first layer.

- 41) The method according to Claim 39, wherein the contacting occurs at the wet end of the papermaking process and produces a facing comprising a web of cellulose fibers and an antimicrobial or fungicide wherein the antimicrobial or fungicide is approximately dispersed evenly throughout the web.

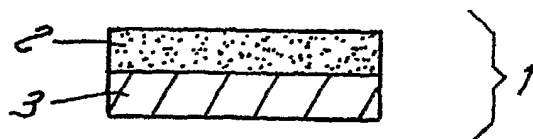


FIG. 1

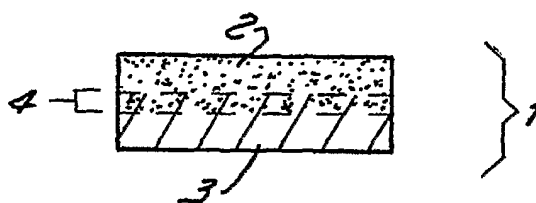


FIG. 2

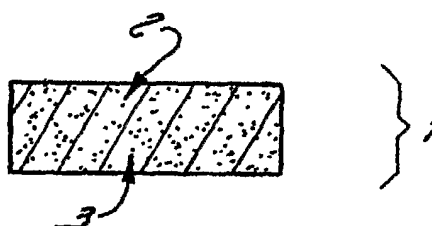


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/023819

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 D21H21/36 D21H27/00 D21H19/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,Y	US 2004/149409 A1 (KLIMPL FRED ET AL) 5 August 2004 (2004-08-05) abstract paragraph '0014! paragraph '0015! paragraph '0016! paragraph '0017! paragraph '0018!	1,23,38
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Y	US 4 533 435 A (INTILI ET AL) 6 August 1985 (1985-08-06) abstract claim 1	1-41
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

25 October 2005

Date of mailing of the international search report

08/11/2005

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INTERNATIONAL SEARCH REPORT

International Application No.
PCT/US2005/023819

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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PCT/US2005/023819

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