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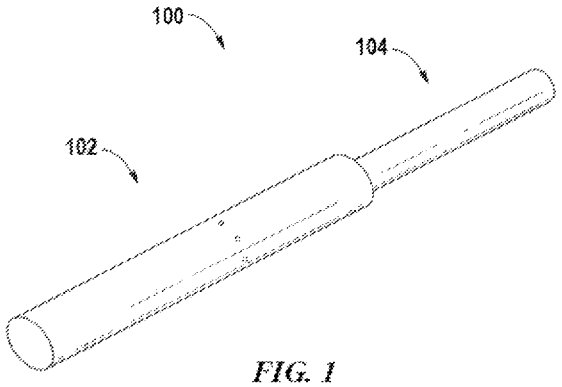

FIG. 1

(57) Abstract: The present disclosure provides a composite substrate configured for use in aerosol generating components for aerosol delivery devices. The composite substrate includes a first substrate material and a second substrate material attached thereto. The first substrate material includes a first filler, a first binder, and a first aerosol forming material, and the second substrate material includes a second filler and a second binder. Further provided are a process for making the composite substrate, and aerosol generating components and aerosol delivery devices including the composite substrate. Such devices utilize electrically generated heat or combustible ignition sources to heat the composite substrate, providing an inhalable substance in the form of an aerosol.

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SUBSTRATE MATERIAL COMPRISING BEADS FOR AEROSOL DELIVERY DEVICES

FIELD OF THE DISCLOSURE

The present disclosure relates to aerosol generating components, aerosol delivery devices, and aerosol delivery systems, such as smoking articles and components that utilize electrically generated heat or combustible ignition sources to heat aerosol forming materials, generally without significant combustion, in order to provide an inhalable substance in the form of an aerosol for human consumption.

BACKGROUND

Many smoking articles have been proposed through the years as improvements upon, or alternatives to, smoking products based upon combusting tobacco for use. Some example alternatives have included devices wherein a solid or liquid fuel is combusted to transfer heat to tobacco or wherein a chemical reaction is used to provide such heat source. Additional example alternatives use electrical energy to heat tobacco and/or other aerosol generating substrate materials, such as described in U.S. Patent No. 9,078,473 to Worm et al., which is incorporated herein by reference in its entirety.

The point of the improvements or alternatives to smoking articles typically has been to provide the sensations associated with cigarette, cigar, or pipe smoking, without delivering considerable quantities of incomplete combustion and pyrolysis products. To this end, there have been proposed numerous smoking products, flavor generators, and medicinal inhalers which utilize electrical energy to vaporize or heat a volatile material, or attempt to provide the sensations of cigarette, cigar, or pipe smoking without burning tobacco to a significant degree. See, for example, the various alternative smoking articles, aerosol delivery devices and heat generating sources set forth in the background art described in U.S. Pat. No. 7,726,320 to Robinson et al.; and U.S. Pat. App. Pub. Nos. 2013/0255702 to Griffith, Jr. et al.; and 2014/0096781 to Sears et al., each of which are incorporated herein by reference in their entireties.

Articles that produce the taste and sensation of smoking by electrically heating tobacco, tobacco-derived materials, or other plant derived materials have suffered from inconsistent performance characteristics. For example, some articles have suffered from inconsistent release of flavors or other inhalable materials, inadequate loading of aerosol forming materials on substrates, or the presence of poor sensory characteristics.

BRIEF SUMMARY

The present disclosure relates to a composite substrate configured for use in aerosol delivery devices that utilize electrically generated heat or combustible ignition sources to heat the substrate in order to provide an inhalable substance in the form of an aerosol for human consumption.

Accordingly, in one aspect, the disclosure provides a composite substrate configured for use in an aerosol delivery device, the composite substrate comprising: a first substrate material comprising a first filler, a

binder, and an aerosol forming material; and a second substrate material attached to the first substrate material, the second substrate material comprising a second filler, a second binder, and a second aerosol forming material.

In some embodiments, the second substrate material is in the form of one or more beads, sphere, or rods adhered to, or imbedded within, the first substrate material. In some embodiments, the second substrate material is in the form of one or more beads.

In some embodiments, the first substrate material is in the form of a sheet. In some embodiments, the first substrate material is in the form of a shredded or particulate material. In some embodiments, both the first substrate material and the second substrate material are in the form of sheets attached together in a layered configuration.

In some embodiments, the first substrate material and the second substrate material have one or more of a different composition, a different density, and a different outer shape. In some embodiments, the density of the first and second substrate materials is different by at least about 10%, such as about 10%, about 15%, or about 20%. In some embodiments, the density of the f second substrate materials is at least about 10% higher than the density of the first substrate material, such as about 10%, about 15%, or about 20% higher.

In some embodiments, the first substrate material comprises at least about 50% by weight of the first filler, based on the total dry weight of the first substrate material. In some embodiments, the first substrate material comprises from about 50% to about 75% by weight of the first filler, based on the total dry weight of the first substrate material.

In some embodiments, the first filler and the second filler are independently selected from the group consisting of a tobacco material, a botanical material, wood pulp, a native or modified starch, maltodextrin, dextrose, calcium carbonate, a sugar alcohol, microcrystalline cellulose, and combinations thereof. In some embodiments, the first filler and the second filler are independently selected from the group consisting of a tobacco material, wood pulp, maltodextrin, calcium carbonate, and combinations thereof. In some embodiments, the first filler and the second filler are independently selected from the group consisting of wood pulp, maltodextrin, calcium carbonate, and combinations thereof.

In some embodiments, the first binder and second binder comprise a cellulose ether independently selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof. In some embodiments, the first binder and the second binder comprise CMC.

In some embodiments, the first aerosol forming material and the second aerosol forming material are independently selected from the group consisting of water, a polyhydric alcohol, a polysorbate, a sorbitan ester, a fatty acid, a fatty acid ester, a wax, a cannabinoid, a terpene, a sugar alcohol, and combinations thereof. In some embodiments, the first aerosol forming material and the second aerosol forming material each comprise a polyhydric alcohol. In some embodiments, the polyhydric alcohol is selected from the group consisting of glycerin, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof.

In some embodiments, the first substrate material comprises: a tobacco material in an amount from about 0 to about 70% by weight, based on the total wet weight of the first substrate material; wood pulp in an amount from about 0 to about 10% by weight, based on the total wet weight of the first substrate material; calcium carbonate in an amount from about 0 to about 30% by weight, based on the total wet weight of the first substrate material; maltodextrin in an amount from about 0 to about 40% by weight, based on the total wet weight of the first substrate material; glycerin in an amount from about 10 to about 20% by weight, based on the total wet weight of the first substrate material; carboxymethylcellulose in an amount from about 5 to about 15% by weight, based on the total wet weight of the first substrate material; and water in an amount up to about 30% by weight, based on the total wet weight of the first substrate material.

In some embodiments, the first substrate material further comprises a flavorant, an active ingredient, a tobacco extract, or a combination thereof. In some embodiments, the active ingredient comprises a nicotine component.

In some embodiments, the beads, sphere, or rods comprise at least about 50% by weight of the second filler, based on the total dry weight of the beads. In some embodiments, the beads, sphere, or rods comprise from about 50% to about 65% by weight of the second filler, based on the total dry weight of the beads.

In some embodiments, the second filler comprises a tobacco material, a botanical material, calcium carbonate, or a combination thereof. In some embodiments, the second filler is selected from the group consisting of a tobacco material, calcium carbonate, and combinations thereof.

In some embodiments, the second binder is selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof. In some embodiments, the second binder is CMC.

In some embodiments, the beads, spheres or rods comprise: a tobacco material in an amount from about 20 to about 40% by weight, based on the total dry weight of the beads, spheres or rods; calcium carbonate in an amount from about 20 to about 40% by weight, based on the total dry weight of the beads, spheres or rods; glycerin in an amount from about 0 to about 20% by weight, based on the total dry weight of the beads, spheres or rods; and carboxymethylcellulose in an amount from about 0 to about 2% by weight, based on the total dry weight of the beads, spheres or rods.

In some embodiments, the beads, spheres or rods further comprise a flavorant, an active ingredient, or a combination thereof.

In some embodiments, the second aerosol forming material is selected from the group consisting of water, a polyhydric alcohol, a polysorbate, a sorbitan ester, a fatty acid, a fatty acid ester, a wax, a cannabinoid, a terpene, a sugar alcohol, and combinations of any thereof. In some embodiments, the polyhydric alcohol is selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof.

In some embodiments, the composite substrate comprises from about 10 to about 50% by weight of the beads, spheres or rods, based on the total weight of the composite substrate.

In some embodiments, the beads, spheres, or rods have a diameter in a range from about 0.1 mm to about 5 mm.

In some embodiments, the beads, spheres or rods are adhered to the surface of the first substrate material in a randomly spaced pattern.

In some embodiments, the beads, spheres or rods are adhered to the surface of the first substrate material in a uniformly spaced pattern.

In some embodiments, the substrate is substantially free of wood fibers. In some embodiments, the substrate is substantially free of tobacco material.

In some embodiments, the composite substrate is in the form of a flat sheet, a gathered sheet, multiple layered sheets, a rolled sheet, or in shredded form. In some embodiments, the composite substrate is in shredded form, further comprising a tobacco material blended therewith.

In another aspect is provided a method of making a composite substrate configured for use in an aerosol delivery device, the method comprising:

(a) preparing a slurry comprising a first filler, a first binder, and a first aerosol forming material;

(b) casting the slurry onto a supportive device to form a first substrate material in the form of a wet sheet;

(c) preparing a second substrate material comprising a second filler, a second binder, and a second aerosol forming material, wherein the second substrate material is in beaded, rod, or sphere form;

(d) depositing the second substrate material onto a surface of the first substrate material; and

(e) drying the first substrate material having deposited thereon the second substrate material in beaded form, to form the composite substrate, wherein the second substrate material in beaded, rod, or sphere form is adhered to a surface of the first substrate material substrate.

In some embodiments, the slurry comprises: a tobacco or botanical material in an amount from about 0 to about 70% by weight, based on the total wet weight of the slurry; wood pulp in an amount from about 0 to about 10% by weight, based on the total wet weight of the slurry; an additional first filler in an amount from about 0 to about 70% by weight, based on the total wet weight of the slurry, the additional first filler comprising a native or modified starch, maltodextrin, dextrose, calcium carbonate, a sugar alcohol, microcrystalline cellulose, or a combination thereof; the first aerosol forming material in an amount from about 10 to about 20% by weight, based on the total wet weight of the slurry; a cellulose ether in an amount from about 5 to about 15% by weight, based on the total wet weight of the slurry; and water in an amount up to about 30% by weight, based on the total wet weight of the slurry.

In some embodiments, the second substrate material in beaded, rod, or sphere form comprises: a tobacco or botanical material in an amount from about 20 to about 40% by weight, based on the total dry weight of the second substrate material; an additional second filler in an amount from about 20 to about 40% by weight, based on the total dry weight of the second substrate material; the second aerosol former in an amount from about 0 to about 20% by weight, based on the total dry weight of the second substrate material; and a cellulose ether in an

amount from about 0 to about 2% by weight, based on the total dry weight of the second substrate material. In some embodiments, the second substrate is in beaded form.

In some embodiments, the method further comprises:

(f) casting a layer of the slurry onto the composite substrate of (e), forming a wet layered composite substrate; and

(g) drying the wet layered composite substrate, forming a layered composite substrate with the second substrate material in beaded, rod, or sphere form embedded therein.

In some embodiments, the second substrate is in beaded form.

In another aspect is provided an aerosol delivery device, comprising the composite substrate as disclosed herein; a heat source configured to heat the aerosol precursor composition in the substrate to form an aerosol; and an aerosol pathway extending from the substrate to a mouth-end of the aerosol delivery device.

In some embodiments, the heat source comprises either an electrically powered heating element or a combustible ignition source. In some embodiments, the heat source is a combustible ignition source comprising a carbon-based material. In some embodiments, the heat source is an electrically powered heating element. In some embodiments, the aerosol delivery device further comprises a power source electronically connected to the heating element. In some embodiments, the aerosol delivery device further comprises a controller configured to control the power transmitted by the power source to the heating element.

The disclosure includes, without limitations, the following embodiments.

Embodiment 1: A composite substrate configured for use in an aerosol delivery device, the composite substrate comprising:

a first substrate material comprising a first filler, a binder, and an aerosol forming material; and

a second substrate material attached to the first substrate material, the second substrate material comprising a second filler, a second binder, and a second aerosol forming material.

Embodiment 2: The composite substrate of embodiment 1, wherein the second substrate material is in the form of one or more beads, sphere, or rods adhered to, or imbedded within, the first substrate material.

Embodiment 3: The composite substrate of embodiment 1 or 2, wherein the first substrate material is in the form of a sheet.

Embodiment 4: The composite substrate of embodiment 1 or 2, wherein the first substrate material is in the form of a shredded or particulate material.

Embodiment 5: The composite substrate of embodiment 1, wherein both the first substrate material and the second substrate material are in the form of sheets attached together in a layered configuration.

Embodiment 6: The composite substrate of any one of embodiments 1-5, wherein the first substrate material and the second substrate material have one or more of a different composition, a different density, and a different outer shape.

Embodiment 7: The composite substrate of embodiment 6, wherein the density of the second substrate material is at least about 10% higher than the density of the first substrate material.

Embodiment 8: The composite substrate of any one of embodiments 1-7, wherein the first substrate material comprises at least about 50% by weight of the first filler, based on the total dry weight of the first substrate material.

Embodiment 9: The composite substrate of any one of embodiments 1-8, wherein the first substrate material comprises from about 50% to about 75% by weight of the first filler, based on the total dry weight of the first substrate material.

Embodiment 10: The composite substrate of any one of embodiments 1-9, wherein the first filler and the second filler are independently selected from the group consisting of a tobacco material, a botanical material, wood pulp, a native or modified starch, maltodextrin, dextrose, calcium carbonate, a sugar alcohol, microcrystalline cellulose, and combinations thereof.

Embodiment 11: The composite substrate of any one of embodiments 1-10, wherein the first filler and the second filler are independently selected from the group consisting of a tobacco material, wood pulp, maltodextrin, calcium carbonate, and combinations thereof.

Embodiment 12: The composite substrate of any one of embodiments 1-10, wherein the first filler and the second filler are independently selected from the group consisting of wood pulp, maltodextrin, calcium carbonate, and combinations thereof.

Embodiment 13: The composite substrate of any one of embodiments 1-12, wherein the first binder and second binder comprise a cellulose ether independently selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof.

Embodiment 14: The composite substrate of any one of embodiments 1-13, wherein the first binder and the second binder comprise CMC.

Embodiment 15: The composite substrate of any one of embodiments 1-15, wherein the first aerosol forming material and the second aerosol forming material are independently selected from the group consisting of water, a polyhydric alcohol, a polysorbate, a sorbitan ester, a fatty acid, a fatty acid ester, a wax, a cannabinoid, a terpene, a sugar alcohol, and combinations thereof.

Embodiment 16: The composite substrate of any one of embodiments 1-15, wherein the first aerosol forming material and the second aerosol forming material each comprise a polyhydric alcohol.

Embodiment 17: The composite substrate of embodiment 16, wherein the polyhydric alcohol is selected from the group consisting of glycerin, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof.

Embodiment 18: The composite substrate of any one of embodiments 1-17, wherein the first substrate material comprises:

a tobacco material in an amount from about 0 to about 70% by weight, based on the total wet weight of the first substrate material;

wood pulp in an amount from about 0 to about 10% by weight, based on the total wet weight of the first substrate material;

calcium carbonate in an amount from about 0 to about 30% by weight, based on the total wet weight of the first substrate material;

maltodextrin in an amount from about 0 to about 40% by weight, based on the total wet weight of the first substrate material;

glycerin in an amount from about 10 to about 20% by weight, based on the total wet weight of the first substrate material;

carboxymethylcellulose in an amount from about 5 to about 15% by weight, based on the total wet weight of the first substrate material; and

water in an amount up to about 30% by weight, based on the total wet weight of the first substrate material.

Embodiment 19: The composite substrate of any one of embodiments 1-18, wherein the first substrate material further comprises a flavorant, an active ingredient, a tobacco extract, or a combination thereof.

Embodiment 20: The composite substrate of any one of embodiments 1-19, wherein the active ingredient comprises a nicotine component.

Embodiment 21: The composite substrate of any one of embodiments 1-20, wherein the beads, sphere, or rods comprise at least about 50% by weight of the second filler, based on the total dry weight of the beads.

Embodiment 22: The composite substrate of any one of embodiments 1-21, wherein the beads, sphere, or rods comprise from about 50% to about 65% by weight of the second filler, based on the total dry weight of the beads.

Embodiment 23: The composite substrate of any one of embodiment 1-22, wherein the second filler comprises a tobacco material, a botanical material, calcium carbonate, or a combination thereof.

Embodiment 24: The composite substrate of any one of embodiments 1-23, wherein the second filler is selected from the group consisting of a tobacco material, calcium carbonate, and combinations thereof.

Embodiment 25: The composite substrate of any one of embodiments 1-24, wherein the second binder is selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof.

Embodiment 26: The composite substrate of any one of embodiments 1-25, wherein the second binder is CMC.

Embodiment 27: The composite substrate of any one of embodiments 1-26, wherein the beads, spheres or rods comprise:

a tobacco material in an amount from about 20 to about 40% by weight, based on the total dry weight of the beads, spheres or rods;

calcium carbonate in an amount from about 20 to about 40% by weight, based on the total dry weight of the beads, spheres or rods;

glycerin in an amount from about 0 to about 20% by weight, based on the total dry weight of the beads, spheres or rods; and

carboxymethylcellulose in an amount from about 0 to about 2% by weight, based on the total dry weight of the beads, spheres or rods.

Embodiment 28: The composite substrate o of any one of embodiments 1-27, wherein the beads, spheres or rods further comprise a flavorant, an active ingredient, or a combination thereof.

Embodiment 29: The composite substrate of any one of embodiments 1-28, wherein the second aerosol forming material is selected from the group consisting of water, a polyhydric alcohol, a polysorbate, a sorbitan ester, a fatty acid, a fatty acid ester, a wax, a cannabinoid, a terpene, a sugar alcohol, and combinations of any thereof.

Embodiment 30: The composite substrate of any one of embodiments 1-29, wherein the polyhydric alcohol is selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof.

Embodiment 31: The composite substrate of any one of embodiments 1-30, comprising from about 10 to about 50% by weight of the beads, spheres or rods, based on the total weight of the composite substrate.

Embodiment 32: The composite substrate of any one of embodiments 1-31, wherein the beads, spheres, or rods have a diameter in a range from about 0.1 mm to about 5 mm.

Embodiment 33: The composite substrate of any one of embodiments 1-32, wherein the beads, spheres or rods are adhered to the surface of the first substrate material in a randomly spaced pattern.

Embodiment 34: The composite substrate of any one of embodiments 1-33, wherein the beads, spheres or rods are adhered to the surface of the first substrate material in a uniformly spaced pattern.

Embodiment 35: The composite substrate of any one of embodiments 1-34, wherein the substrate is substantially free of wood fibers.

Embodiment 36: The composite substrate of any one of embodiments 1-35, wherein the substrate is substantially free of tobacco material.

Embodiment 37: The composite substrate of any one of embodiments 1-36, in the form of a flat sheet, a gathered sheet, multiple layered sheets, a rolled sheet, or in shredded form.

Embodiment 38: The composite substrate of any one of embodiments 1-36 in shredded form, further comprising a tobacco material blended therewith.

Embodiment 39: An aerosol delivery device, comprising:

the composite substrate of any one of embodiments 1-38;

a heat source configured to heat the composite substrate to form an aerosol; and

an aerosol pathway extending from the composite substrate to a mouth-end of the aerosol delivery device.

Embodiment 40: The aerosol delivery device of embodiment 39, wherein the heat source comprises either an electrically powered heating element or a combustible ignition source.

Embodiment 41: The aerosol delivery device of embodiment 40, wherein the heat source is a combustible ignition source comprising a carbon-based material.

Embodiment 42: The aerosol delivery device of embodiment 40, wherein the heat source is an electrically powered heating element.

Embodiment 43: The aerosol delivery device of embodiment 42, further comprising a power source electronically connected to the heating element.

Embodiment 44: The aerosol delivery device of embodiment 43, further comprising a controller configured to control the power transmitted by the power source to the heating element.

Embodiment 45: A method of making a composite substrate configured for use in an aerosol delivery device, the method comprising:

(a) preparing a slurry comprising a first filler, a first binder, and a first aerosol forming material;

(b) casting the slurry onto a supportive device to form a first substrate material in the form of a wet sheet;

(c) preparing a second substrate material comprising a second filler, a second binder, and a second aerosol forming material, wherein the second substrate material is in beaded form;

(d) depositing the second substrate material onto a surface of the first substrate material; and

(e) drying the first substrate material having deposited thereon the second substrate material in beaded form, to form the composite substrate, wherein the second substrate material in beaded form is adhered to a surface of the first substrate material substrate.

Embodiment 46: The method of embodiment 45, wherein the slurry comprises:

a tobacco or botanical material in an amount from about 0 to about 70% by weight, based on the total wet weight of the slurry;

wood pulp in an amount from about 0 to about 10% by weight, based on the total wet weight of the slurry;

an additional first filler in an amount from about 0 to about 70% by weight, based on the total wet weight of the slurry, the additional first filler comprising a native or modified starch, maltodextrin, dextrose, calcium carbonate, a sugar alcohol, microcrystalline cellulose, or a combination thereof;

the first aerosol forming material in an amount from about 10 to about 20% by weight, based on the total wet weight of the slurry;

a cellulose ether in an amount from about 5 to about 15% by weight, based on the total wet weight of the slurry; and

water in an amount up to about 30% by weight, based on the total wet weight of the slurry.

Embodiment 47: The method of embodiment 46, wherein the second substrate material in beaded form comprises:

a tobacco or botanical material in an amount from about 20 to about 40% by weight, based on the total dry weight of the second substrate material;

an additional second filler in an amount from about 20 to about 40% by weight, based on the total dry weight of the second substrate material;

the second aerosol former in an amount from about 0 to about 20% by weight, based on the total dry weight of the second substrate material; and

a cellulose ether in an amount from about 0 to about 2% by weight, based on the total dry weight of the second substrate material.

Embodiment 48: The method of embodiment 46, further comprising:

(f) casting a layer of the slurry onto the composite substrate of (e), forming a wet layered composite substrate; and

(g) drying the wet layered composite substrate, forming a layered composite substrate with the second substrate material in beaded form embedded therein.

These and other features, aspects, and advantages of the disclosure will be apparent from a reading of the following detailed description together with the accompanying drawings, which are briefly described below. The invention includes any combination of two, three, four, or more of the above-noted embodiments as well as combinations of any two, three, four, or more features or elements set forth in this disclosure, regardless of whether such features or elements are expressly combined in a specific embodiment description herein. This disclosure is intended to be read holistically such that any separable features or elements of the disclosed invention, in any of its various aspects and embodiments, should be viewed as intended to be combinable unless the context clearly dictates otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus described aspects of the disclosure in the foregoing general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale. The drawings are exemplary only and should not be construed as limiting the disclosure.

FIG. 1 illustrates a perspective view of an aerosol delivery device comprising a control body and an aerosol generating component, wherein the aerosol generating component and the control body are coupled to one another, according to an example embodiment of the present disclosure;

FIG. 2 illustrates a perspective view of the aerosol delivery device of FIG. 1, wherein the aerosol generating component and the control body are decoupled from one another, according to an example embodiment of the present disclosure;

FIG. 3 illustrates a perspective schematic view of an aerosol generating component, according to an example embodiment of the present disclosure;

FIG. 4 illustrates a schematic cross-section drawing of a substrate portion of an aerosol generating component, according to an example embodiment of the present disclosure;

FIG. 5 illustrates a perspective view of an aerosol generating component, according to an example embodiment of the present disclosure;

FIG. 6 illustrates a perspective view of the aerosol generating component of FIG. 5 with an outer wrap removed, according to one embodiment of the present disclosure;

FIG. 7 is a photograph of an example composite substrate according to an embodiment of the disclosure having a plurality of beads adhered to a first substrate material in the form of a sheet;

FIG. 8 is a photograph of another example composite substrate according to an embodiment of the disclosure having a plurality of beads adhered to a first substrate material in the form of a sheet; and

FIG. 9 is a photograph of yet another example composite substrate according to an embodiment of the disclosure having a plurality of beads adhered to a first substrate material in the form of a sheet.

DETAILED DESCRIPTION

The present disclosure will now be described more fully hereinafter with reference to example embodiments thereof. These example embodiments are described so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Indeed, the disclosure may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. As used in this specification and the claims, the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Reference to "dry weight percent" or "dry weight basis" refers to weight on the basis of dry ingredients (i.e., all ingredients except water). Reference to percent is intended to mean percent by weight unless otherwise indicated. As used herein, "substantially free" refers to concentrations of a given substance of less than 1% by weight or less than 0.5% by weight or less than 0.1% by weight based on total weight of a material. Reference to percent is intended to mean percent by weight unless otherwise indicated.

I. Composite Substrate

As described hereinafter, example embodiments of the present disclosure relate to a composite substrate configured for use in an aerosol delivery device. The substrate comprises a first substrate material and a second substrate material. The second substrate material is attached to the first substrate material. Each of the first and second substrate material may comprise, for example, components such as fillers, binders, aerosol generating materials, flavorants, and active ingredients, independently chosen for each of the first and second substrate material. Each of these components is described further herein below, along with additional substrate components.

Filler

The substrate as disclosed herein comprises a filler in each of the first substrate material and the second substrate material. The filler is independently selected for each of the first substrate material and the second substrate material. Suitable fillers include, but are not limited to, tobacco materials, botanical materials, starches,

sugars, sugar alcohols, wood fibers, inorganic substances, inert materials, and the like. Examples of suitable fillers are described further herein below.

Starch

In some embodiments, the filler comprises a starch, including native and modified starches. "Starch" as used herein may refer to pure starch from any source, modified starch, or starch derivatives. Starch is present, typically in granular form, in almost all green plants and in various types of plant tissues and organs (e.g., seeds, leaves, rhizomes, roots, tubers, shoots, fruits, grains, and stems). Starch can vary in composition, as well as in granular shape and size. Often, starch from different sources has different chemical and physical characteristics, resulting in starch exhibiting several functional application properties. A specific starch can be selected for inclusion e.g., in a beaded substrate based on the ability of the starch material to impart a specific organoleptic property to the beads. Starches derived from various sources can be used. For example, major sources of starch include cereal grains (e.g., rice, wheat, oats, barley, rye, and maize) and root vegetables (e.g., potatoes and cassava). Other examples of sources of starch include acorns, arrowroot, arracacha, bananas, barley, beans (e.g., favas, lentils, mung beans, peas, chickpeas), breadfruit, buckwheat, canna, chestnuts, colacasia, katakuri, kudzu, malanga, t, oca, Polynesian arrowroot, sago, sorghum, millet, sweet potato, quinoa, tapioca, taro, tobacco, water chestnuts, and yams. Suitable starches include, but are not limited to, corn starch, rice starch, and modified food starches. Certain starches are modified starches. A modified starch has undergone one or more structural modifications, often designed to alter its high heat properties. Some starches have been developed by genetic modifications and are considered to be "modified" starches. Other starches are obtained and subsequently modified. For example, modified starches can be starches that have been subjected to chemical reactions, such as esterification, etherification, oxidation, depolymerization (thinning) by acid or base catalysis, or oxidation in the presence of base, bleaching, transglycosylation and depolymerization (e.g., dextrinization in the presence of a catalyst), cross-linking, enzyme treatment, acetylation, hydroxypropylation, and/or partial hydrolysis. Other starches are modified by heat treatments, such as pregelatinization, dextrinization, and/or cold water swelling processes. Certain modified starches include monostarch phosphate, distarch glycerol, distarch phosphate esterified with sodium trimetaphosphate, phosphate distarch phosphate, acetylated distarch phosphate, starch acetate esterified with acetic anhydride, starch acetate esterified with vinyl acetate, acetylated distarch adipate, acetylated distarch glycerol, hydroxypropyl starch, hydroxypropyl distarch glycerol, and starch sodium octenyl succinate.

Cellulose material

In some embodiments, the filler comprises a cellulose material, such as microcrystalline cellulose ("mcc"). The mcc may be synthetic or semi-synthetic, or it may be obtained entirely from natural celluloses. The mcc may be selected from the group consisting of AVICEL® grades PH-100, PH-102, PH-103, PH-105, PH-112, PH-113, PH-200, PH-300, PH-302, VIVACEL® grades 101, 102, 12, 20 and EMOCEL® grades 50M and

90M, and the like, and mixtures thereof. In some embodiments, the cellulosic material is wood fibers, wood-derived fibers or ground /powdered cellulose.

Tobacco

In some embodiments, the filler comprises a tobacco material. The tobacco material can vary in species, type, and form. Generally, the tobacco material is obtained from for a harvested plant of the *Nicotiana* species. Example *Nicotiana* species include N. tabacum, N. rustica, N. alata, N. arentsii, N. excelsior, N. forgetiana, N. glauca, N. glutinosa, N. gossei, N. kawakamii, N. knightiana, N. langsdorffi, N. otophora, N. setchelli, N. sylvestris, N. tomentosa, N. tomentosiformis, N. undulata, N. x sanderae, N. africana, N. amplexicaulis, N. benavidesii, N. bonariensis, N. debneyi, N. longiflora, N. maritina, N. megalosiphon, N. occidentalis, N. paniculata, N. plumbaginifolia, N. raimondii, N. rosulata, N. simulans, N. stocktonii, N. suaveolens, N. umbratica, N. velutina, N. wigandioides, N. acaulis, N. acuminata, N. attenuata, N. benthamiana, N. cavicola, N. clevelandii, N. cordifolia, N. corymbosa, N. fragrans, N. goodspeedii, N. linearis, N. miersii, N. nudicaulis, N. obtusifolia, N. occidentalis subsp. Hersperis, N. pauciflora, N. petunioides, N. quadrivalvis, N. repanda, N. rotundifolia, N. solanifolia, and N. spegazzinii. Various representative other types of plants from the *Nicotiana* species are set forth in Goodspeed, *The Genus Nicotiana*, (Chonica Botanica) (1954); US Pat. Nos. 4,660,577 to Sensabaugh, Jr. et al.; 5,387,416 to White et al., 7,025,066 to Lawson et al.; 7,798,153 to Lawrence, Jr. and 8,186,360 to Marshall et al.; each of which is incorporated herein by reference. Descriptions of various types of tobaccos, growing practices and harvesting practices are set forth in *Tobacco Production, Chemistry and Technology*, Davis et al. (Eds.) (1999), which is incorporated herein by reference.

Nicotiana species from which suitable tobacco materials can be obtained can be derived using genetic-modification or crossbreeding techniques (e.g., tobacco plants can be genetically engineered or crossbred to increase or decrease production of components, characteristics or attributes). See, for example, the types of genetic modifications of plants set forth in US Pat. Nos. 5,539,093 to Fitzmaurice et al.; 5,668,295 to Wahab et al.; 5,705,624 to Fitzmaurice et al.; 5,844,119 to Weigl; 6,730,832 to Dominguez et al.; 7,173,170 to Liu et al.; 7,208,659 to Colliver et al. and 7,230,160 to Benning et al.; US Patent Appl. Pub. No. 2006/0236434 to Conkling et al.; and PCT WO2008/103935 to Nielsen et al. See, also, the types of tobaccos that are set forth in US Pat. Nos. 4,660,577 to Sensabaugh, Jr. et al.; 5,387,416 to White et al.; and 6,730,832 to Dominguez et al., each of which is incorporated herein by reference.

The *Nicotiana* species can, in some embodiments, be selected for the content of various compounds that are present therein. For example, plants can be selected on the basis that those plants produce relatively high quantities of one or more of the compounds desired to be isolated therefrom. In certain embodiments, plants of the *Nicotiana* species (e.g., *Galpao commun* tobacco) are specifically grown for their abundance of leaf surface compounds. Tobacco plants can be grown in greenhouses, growth chambers, or outdoors in fields, or grown hydroponically.

Various parts or portions of the plant of the *Nicotiana* species can be included within a substrate as disclosed herein. For example, virtually all of the plant (*e.g.*, the whole plant) can be harvested, and employed as such. Alternatively, various parts or pieces of the plant can be harvested or separated for further use after harvest. For example, the flower, leaves, stem, stalk, roots, seeds, and various combinations thereof, can be isolated for further use or treatment. In some embodiments, the milled tobacco material comprises tobacco leaf (lamina). The substrate disclosed herein can include processed tobacco parts or pieces, cured and aged tobacco in essentially natural lamina and/or stem form. In certain embodiments, the tobacco material comprises solid tobacco material selected from the group consisting of lamina and stems. The tobacco that is used for the substrate most preferably includes tobacco lamina, or a tobacco lamina and stem mixture (of which at least a portion is smoke treated). Portions of the tobacco may have processed forms, such as processed tobacco stems (e.g., cut-rolled stems, cut-rolled-expanded stems or cut-puffed stems), or volume expanded tobacco (e.g., puffed tobacco, such as dry ice expanded tobacco (DIET)). See, for example, the tobacco expansion processes set forth in US Pat. Nos. 4,340,073 to de la Burde et al.; 5,259,403 to Guy et al.; and 5,908,032 to Poindexter, et al.; and 7,556,047 to Poindexter, et al., all of which are incorporated by reference. In addition, the substrate may incorporate tobacco that has been fermented. See, also, the types of tobacco processing techniques set forth in PCT WO2005/063060 to Atchley et al., which is incorporated herein by reference.

The tobacco material is typically used in a form that can be described as particulate (i.e., shredded, ground, granulated, or powder form). Most preferably, the tobacco material is employed in the form of parts or pieces that have an average particle size between 1.4 millimeters and 250 microns. In some instances, the tobacco particles may be sized to pass through a screen mesh to obtain the particle size range required. If desired, air classification equipment may be used to ensure that small sized tobacco particles of the desired sizes, or range of sizes, may be collected. If desired, differently sized pieces of granulated tobacco may be mixed together.

The manner by which the tobacco material is provided in a finely divided or powder type of form may vary. Preferably, plant parts or pieces are comminuted, ground or pulverized into a particulate form using equipment and techniques for grinding, milling, or the like. The plant, or parts thereof, can be subjected to external forces or pressure (e.g., by being pressed or subjected to roll treatment). When carrying out such processing conditions, the plant or portion thereof can have a moisture content that approximates its natural moisture content (e.g., its moisture content immediately upon harvest), a moisture content achieved by adding moisture to the plant or portion thereof, or a moisture content that results from the drying of the plant or portion thereof. For example, powdered, pulverized, ground or milled pieces of plants or portions thereof can have moisture contents of less than about 25 weight percent, often less than about 20 weight percent, and frequently less than about 15 weight percent. Most preferably, the plant material is relatively dry in form during grinding or milling, using equipment such as hammer mills, cutter heads, air control mills, or the like. For example, tobacco parts or pieces may be ground or milled when the moisture content thereof is less than about 15 weight percent or less than about 5 weight percent.

For the preparation of substrates (e.g., base and beaded materials), it is typical for a harvested plant of the *Nicotiana* species to be subjected to a curing process. The tobacco materials incorporated within the substrates as disclosed herein are generally those that have been appropriately cured and/or aged. Descriptions of various types of curing processes for various types of tobaccos are set forth in *Tobacco Production, Chemistry and Technology,* Davis et al. (Eds.) (1999). Examples of techniques and conditions for curing flue-cured tobacco are set forth in Nestor et al., *Beitrage Tabakforsch. Int.,* 20, 467-475 (2003) and US Pat. No. 6,895,974 to Peele, which are incorporated herein by reference. Representative techniques and conditions for air curing tobacco are set forth in US Pat. No. 7,650,892 to Groves et al.; Roton et al., *Beitrage Tabakforsch. Int.,* 21, 305-320 (2005) and Staaf et al., *Beitrage Tabakforsch. Int.,* 21, 321-330 (2005), which are incorporated herein by reference. Certain types of tobaccos can be subjected to alternative types of curing processes, such as fire curing or sun curing.

In certain embodiments, tobacco materials that can be employed include flue-cured or Virginia (e.g., K326), burley, sun-cured (e.g., Indian Kurnool and Oriental tobaccos, including Katerini, Prelip, Komotini, Xanthi and Yambol tobaccos), Maryland, dark, dark-fired, dark air cured (e.g., Madole, Passanda, Cubano, Jatin and Bezuki tobaccos), light air cured (e.g., North Wisconsin and Galpao tobaccos), Indian air cured, Red Russian and *Rustica* tobaccos, as well as various other rare or specialty tobaccos and various blends of any of the foregoing tobaccos.

The tobacco material may also have a so-called "blended" form. For example, the tobacco material may include a mixture of parts or pieces of flue-cured, burley (e.g., Malawi burley tobacco) and Oriental tobaccos (e.g., as tobacco composed of, or derived from, tobacco lamina, or a mixture of tobacco lamina and tobacco stem). For example, a representative blend may incorporate about 30 to about 70 parts burley tobacco (e.g., lamina, or lamina and stem), and about 30 to about 70 parts flue cured tobacco (e.g., stem, lamina, or lamina and stem) on a dry weight basis. Other example tobacco blends incorporate about 75 parts flue-cured tobacco, about 15 parts burley tobacco, and about 10 parts Oriental tobacco; or about 65 parts flue-cured tobacco, about 25 parts burley tobacco, and about 10 parts Oriental tobacco; or about 65 parts flue-cured tobacco, about 10 parts burley tobacco, and about 25 parts Oriental tobacco; on a dry weight basis. Other example tobacco blends incorporate about 20 to about 30 parts Oriental tobacco and about 70 to about 80 parts flue-cured tobacco on a dry weight basis.

Tobacco materials used in the present disclosure can be subjected to, for example, fermentation, bleaching, and the like. If desired, the tobacco materials can be, for example, irradiated, pasteurized, or otherwise subjected to controlled heat treatment. Such treatment processes are detailed, for example, in US Pat. No. 8,061,362 to Mua et al., which is incorporated herein by reference. In certain embodiments, tobacco materials can be treated with water and an additive capable of inhibiting reaction of asparagine to form acrylamide upon heating the tobacco material (e.g., an additive selected from the group consisting of lysine, glycine, histidine, alanine, methionine, cysteine, glutamic acid, aspartic acid, proline, phenylalanine, valine, arginine, compositions incorporating di- and trivalent cations, asparaginase, certain non-reducing saccharides,

certain reducing agents, phenolic compounds, certain compounds having at least one free thiol group or functionality, oxidizing agents, oxidation catalysts, natural plant extracts (e.g., rosemary extract), and combinations thereof. See, for example, the types of treatment processes described in US Pat. Pub. Nos. 8,434,496, 8,944,072, and 8,991,403 to Chen et al., which are all incorporated herein by reference. In certain embodiments, this type of treatment is useful where the original tobacco material is subjected to heat in the processes previously described.

The tobacco material may be processed to remove at least a portion of the nicotine present. Suitable methods of extracting nicotine from tobacco material are known in the art. In some embodiments, the milled tobacco material is substantially free of nicotine. By "substantially free" is meant that only trace amounts are present in the tobacco material. For example, in certain embodiments, the tobacco material can be characterized as having less than 0.001% by weight of nicotine, or less than 0.0001%, or even 0% by weight of nicotine, calculated as the free base, and based on the total weight of the tobacco material.

Tobacco-derived materials

In some embodiments, the filler comprises a tobacco-derived material, for example, a tobacco extract, such as an aqueous tobacco extract, added either as a component of the aerosol forming material, or added separately (e.g., during substrate preparation, or impregnated in the substrate after formation). "Tobacco extract" as used herein refers to the isolated components of a tobacco material that are extracted from solid tobacco pulp by a solvent (e.g., water) that is brought into contact with the tobacco material in an extraction process. Various extraction techniques of tobacco materials can be used to provide a tobacco extract and tobacco solid material. See, for example, the extraction processes described in US Pat. Appl. Pub. No. 2011/0247640 to Beeson et al., which is incorporated herein by reference. Other example techniques for extracting components of tobacco are described in US Pat. Nos. 4,144,895 to Fiore; 4,150,677 to Osborne, Jr. et al.; 4,267,847 to Reid; 4,289,147 to Wildman et al.; 4,351,346 to Brummer et al.; 4,359,059 to Brummer et al.; 4,506,682 to Muller; 4,589,428 to Keritsis; 4,605,016 to Soga et al.; 4,716,911 to Poulose et al.; 4,727,889 to Niven, Jr. et al.; 4,887,618 to Bernasek et al.; 4,941,484 to Clapp et al.; 4,967,771 to Fagg et al.; 4,986,286 to Roberts et al.; 5,005,593 to Fagg et al.; 5,018,540 to Grubbs et al.; 5,060,669 to White et al.; 5,065,775 to Fagg; 5,074,319 to White et al.; 5,099,862 to White et al.; 5,121,757 to White et al.; 5,131,414 to Fagg; 5,131,415 to Munoz et al.; 5,148,819 to Fagg; 5,197,494 to Kramer; 5,230,354 to Smith et al.; 5,234,008 to Fagg; 5,243,999 to Smith; 5,301,694 to Raymond et al.; 5,318,050 to Gonzalez-Parra et al.; 5,343,879 to Teague; 5,360,022 to Newton; 5,435,325 to Clapp et al.; 5,445,169 to Brinkley et al.; 6,131,584 to Lauterbach; 6,298,859 to Kierulff et al.; 6,772,767 to Mua et al.; and 7,337,782 to Thompson, all of which are incorporated by reference herein.

Non-Tobacco Botanicals

In some embodiments, the filler comprises a non-tobacco botanical material. As used herein, the term "botanical ingredient" or "botanical" refers to any plant material or fungal-derived material, including plant material in its natural form and plant material derived from natural plant materials, such as extracts or isolates from plant materials or treated plant materials (e.g., plant materials subjected to heat treatment, fermentation, or

other treatment processes capable of altering the chemical nature of the material). For the purposes of the present disclosure, a "botanical material" includes but is not limited to "herbal materials," which refer to seed-producing plants that do not develop persistent woody tissue and are often valued for their medicinal or sensory characteristics (e.g., teas or tisanes). Reference to botanical material as "non-tobacco" is intended to exclude tobacco materials (i.e., does not include any *Nicotiana* species). The botanical materials used in the present disclosure may comprise, without limitation, any of the compounds and sources set forth herein, including mixtures thereof. Certain botanical materials of this type are sometimes referred to as dietary supplements, nutraceuticals, "phytochemicals" or "functional foods."

Non-limiting examples of botanical materials include without limitation acai berry, alfalfa, allspice, Angelica root, anise (e.g., star anise), annatto seed, apricot oil, bacopa monniera, basil, bee balm, beet root, bergamot, black cohosh, black pepper, black tea, blueberries, borage, bugleweed, cacao, calamus root, cannabis/hemp, caraway seed, catnip, catuaba, cayenne, cayenne pepper, chaga mushroom, chamomile, chervil, chocolate, cinnamon, clary sage, cloves, coffee, comfrey leaf and root, coriander seed, cranberry, dandelion, Echinacea, elderberry, elderflower, evening primrose, eucalyptus, fennel, feverfew, garlic, ginger, gingko biloba, ginseng, goji berries, goldenseal, grape seed, grapefruit, green tea, gutu kola, hawthorn, hibiscus flower, honeybush, jiaogulan, kava, jasmine, lavender, licorice, lilac, Lion's mane, marjoram, milk thistle, mints (menthe), oolong tea, orange, oregano, papaya, pennyroyal, peppermint (*Mentha piperita*), potato peel, quince, red clover, rooibos (red or green), rosehip, rosemary, sage, Saint John's Wort, savory, saw palmetto, silybum marianum, slippery elm bark, sorghum bran hi-tannin, sorghum grain hi-tannin, spearmint, spirulina, sumac bran, thyme, turmeric, uva ursi, valerian, wild yam root, wintergreen, withania somnifera, yacon root, yellow dock, yerba mate, and yerba santa.

In some embodiments, the non-tobacco botanical material is milled. In some embodiments, the milled non-tobacco botanical material comprises eucalyptus, rooibos, star anise, fennel, or combinations thereof.

The non-tobacco botanical material in milled form may have a range of particle sizes. For example, in some embodiments, the milled non-tobacco botanical material has a particle size of from about 0.05 mm to about 1 mm. In some instances, the non-tobacco botanical material particles may be sized to pass through a screen mesh to obtain the particle size range required.

In some embodiments, the non-tobacco botanical material is present in the form of an extract. "Botanical extract" as used herein refers to the isolated components of a botanical material that are extracted from a solid botanical material by a solvent (e.g., water, alcohol, or the like) that is brought into contact with the solid botanical material in an extraction process. Various extraction techniques of solid botanical materials can be used to provide a botanical material extract. In some embodiments, the botanical extract is an extract of Angelica root, caraway seed, cinnamon, clove, coriander seeds, elderberry, elderflower, ginger, jasmine, lavender, lilac, peppermint (*Mentha piperita*), quince, or combinations thereof.

Inorganic/inert substances

In some embodiments, the filler comprises an inorganic substance or inert substance, such as, but not limited to, chitosan, carbons (graphite, diamond, fullerenes, graphene), quartz, granite, diatomaceous earth, calcium carbonate, calcium phosphate, clays, crustacean and other marine shells, or combinations thereof. In some embodiments, the filler comprises calcium carbonate.

Sugars and Sugar Alcohols

In some embodiments, the filler comprises a sugar. Examples of suitable sugars include, but are not limited to, dextrose, maltose, maltotriose, galactose, and lactose. In some embodiments, the filler comprises a sugar alcohol. Sugar alcohols are polyols derived from monosaccharides or disaccharides that have a partially or fully hydrogenated form. Sugar alcohols have, for example, about 4 to about 20 carbon atoms and include erythritol, arabitol, ribitol, isomalt, maltitol, dulcitol, iditol, mannitol, xylitol, lactitol, sorbitol, and combinations thereof (e.g., hydrogenated starch hydrolysates).

Binder

The substrate as disclosed herein comprises a binder in the first substrate material, the second substrate material, or both. Various binders may be used to assist in maintaining the integrity of the first substrate material, the second substrate material, or both intact. The binders are independently selected for each of the first substrate material and the second substrate material. Typical binders can be organic or inorganic, or a combination thereof. Representative binders include, but are not limited to, polymers such as povidone, sodium alginate, pectin, gums, carrageenan, pullulan, xanthan, agar, acacia, zein, cellulose derivatives, and the like, and combinations thereof. Other examples of binder materials are described, for example, in U.S. Pat. No. 5,101,839 to Jakob et al.; and U.S. Pat. No. 4,924,887 to Raker et al., each of which is incorporated herein by reference in its entirety.

In some embodiments, the binder is an alginate, such as ammonium alginate, propylene glycol alginate, potassium alginate, or sodium alginate. Alginates, and particularly high viscosity alginates, may be employed in conjunction with controlled levels of free calcium ions. In some embodiments, the binder comprises a carrageenan. In some embodiments, the binder comprises agar.

In some embodiments, the binder is a gum, for example, a natural gum. As used herein, a natural gum refers to polysaccharide materials of natural origin that have binding properties, and which are also useful as a thickening or gelling agents. Representative natural gums derived from plants, which are typically water soluble to some degree, include xanthan gum, guar gum, gum arabic, ghatti gum, gum tragacanth, karaya gum, locust bean gum, gellan gum, and combinations thereof. In some embodiments, binder comprises xanthan gum, guar gum, gum Arabic, locust bean gum, gum tragacanth, or a combination thereof. Other suitable gums include modified gums, such as hydroxyethyl guar, hydroxypropyl guar, hydroxyethyl locust bean gum, or hydroxypropyl locust bean gum.

In some embodiments, the binder is a pectin, such as fruit, citrus or tobacco pectins. Pectins are generally known to act as hygroscopic agents which facilitate the retention of moisture.

In some embodiments, the binder is a cellulose derivative. In some embodiments, the cellulose derivative is a cellulose ether, meaning a cellulose polymer with the hydrogen of one or more hydroxyl groups in the cellulose structure replaced with an alkyl, hydroxyalkyl, or aryl group. In some embodiments, the cellulose derivative is a hydroxyalkyl cellulose ether. Non-limiting examples of such cellulose derivatives include methylcellulose, hydroxypropylcellulose ("HPC"), hydroxypropylmethylcellulose ("HPMC"), and hydroxyethyl cellulose. Suitable cellulose ethers include hydroxypropylcellulose, such as Klucel H from Aqualon Co.; hydroxypropylmethylcellulose, such as Methocel K4MS from DuPont; hydroxyethylcellulose, such as Natrosol 250 MRCS from Aqualon Co.; methylcellulose, such as Methocel A4M, K4M, and E15 from DuPont.; and sodium carboxymethylcellulose, such as CMC 7HF, CMC 7LF, and CMC 7H4F from Aqualon Co.

Aerosol Forming Material

The substrate as disclosed herein comprises an aerosol forming material in the first substrate material, the second substrate material, or both. The aerosol forming materials are independently selected for each of the first substrate material and the second substrate material. Suitable an aerosol forming materials include, but are not limited to, water, polyhydric alcohols, polysorbates, sorbitan esters, fatty acids, fatty acid esters, waxes, terpenes, sugar alcohols, tobacco extract, and combinations thereof. In some embodiments, the aerosol forming material may include water, polyhydric alcohols, polysorbates, sorbitan esters, fatty acids, fatty acid esters, waxes, terpenes, sugar alcohols, tobacco extract, or a combination of any thereof. Each of polyhydric alcohols, polysorbates, sorbitan esters, fatty acids, fatty acid esters, waxes, terpenes, and sugar alcohols are further described herein.

Polyhydric alcohols

In some embodiments, the aerosol forming material comprises one or more polyhydric alcohols. Examples of polyhydric alcohols include glycerol, propylene glycol, and other glycols such as 1,3-propanediol, diethylene glycol, and triethylene glycol. In some embodiments, the polyhydric alcohol is selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof.

In some embodiments, the polyhydric alcohol is a mixture of glycerol and propylene glycol. The glycerol and propylene glycol may be present in various ratios, with either component predominating depending on the intended application. In some embodiments, the glycerol and propylene glycol are present in a ratio by weight of from about 3:1 to about 1:3. In some embodiments, the glycerol and propylene glycol are present in a ratio by weight of about 3:1, about 2:1, about 1:1, about 1:2, or about 1:3. In some embodiments, the glycerol and propylene glycol are present in a ratio of about 1:1 by weight.

Polysorbates and Sorbitan Esters

In some embodiments, the aerosol forming material comprises one or more polysorbates. Examples of polysorbates include Polysorbate 60 (polyoxyethylene (20) sorbitan monostearate, Tween 60) and Polysorbate 80 (polyoxyethylene (20) sorbitan monooleate, Tween 80). The type of polysorbate used or the combination of polysorbates used depends on the intended effect desired, as the different polysorbates offer different attributes due to molecular sizes. For example, the polysorbate molecules increase in size from polysorbate 20 to polysorbate 80. Using smaller size polysorbate molecules creates less vapor quantity, but permits deeper lung penetration. This may be desirable when the user is in public where he would not want to create a large plume of "smoke" (i.e. vapors). Conversely, if a dense vapor is desired, which can convey the aromatic constituents of tobacco, larger polysorbate molecules can be employed. An additional benefit of using the polysorbate family of compounds is that the polysorbates lower the heat of vaporization of mixtures in which they are present.

In some embodiments, the aerosol forming material comprises one or more sorbitan esters. Examples of sorbitan esters include sorbitan monolaurate, sorbitan monostearate (Span 60), sorbitan monooleate (Span 20), and sorbitan tristearate (Span 65).

Fatty Acids, Esters, and Waxes

In some embodiments, the aerosol forming material comprises one or more fatty acids. Fatty acids may include short-chain, long-chain, saturated, unsaturated, straight chain, or branched chain carboxylic acids. Fatty acids generally include C_4 to C_{28} aliphatic carboxylic acids. Non-limiting examples of short- or long-chain fatty acids include butyric, propionic, valeric, oleic, linoleic, stearic, myristic, and palmitic acids.

In some embodiments, the aerosol forming material comprises one or more fatty acid esters. Examples of fatty acid esters include alkyl esters, monoglycerides, diglycerides, and triglycerides. Examples of monoglycerides include monolaurin and glycerol monostearate. Examples of triglycerides include triolein, tripalmitin, tristearate, glycerol tributyrate, and glycerol trihexanoate).

In some embodiments, the aerosol forming material comprises one or more waxes. Examples of waxes include carnauba, beeswax, candellila, which are known known to stabilize aerosol particles, improve palatability, or reduce throat irritation.

Terpenes

In some embodiments, the aerosol forming material comprises one or more terpenes. As used herein, the term "terpenes" refers to hydrocarbon compounds produced by plants biosynthetically from isopentenyl pyrophosphate. Terpenes are understood to have the general formula of $(C_5H_8)_n$ and include monoterpenes, sesquiterpenes, and diterpenes. Terpenes can be acyclic, monocyclic or bicyclic in structure. Some terpenes provide an entourage effect when used in combination with cannabinoids or cannabimimetics. Examples include beta-caryophyllene, linalool, limonene, beta-citronellol, linalyl acetate, pinene (alpha or beta), geraniol, carvone,

eucalyptol, menthone, iso-menthone, piperitone, myrcene, beta-bourbonene, and germacrene, which may be used singly or in combination.

In some embodiments, the terpene is a terpene derivable from a phytocannabinoid producing plant, such as a plant from the stain of the cannabis sativa species, such as hemp. Suitable terpenes in this regard include so-called "C10" terpenes, which are those terpenes comprising 10 carbon atoms, and so-called "C15" terpenes, which are those terpenes comprising 15 carbon atoms. In some embodiments, the active ingredient comprises more than one terpene. For example, the active ingredient may comprise one, two, three, four, five, six, seven, eight, nine, ten or more terpenes as defined herein. In some embodiments, the terpene is selected from pinene (alpha and beta), geraniol, linalool, limonene, carvone, eucalyptol, menthone, iso-menthone, piperitone, myrcene, beta-bourbonene, germacrene and mixtures thereof.

Active ingredient

In some embodiments, the substrate as disclosed herein may comprise one or more active ingredients in the first substrate material, the second substrate material, or both. The active ingredient may be added either as a component of the aerosol forming material, the first substrate material, or the second substrate material, or may be added separately (e.g., impregnated in the substrate after formation). The active ingredient may be independently selected for each of the first substrate material and second substrate material. As used herein, an "active ingredient" refers to one or more substances belonging to any of the following categories: API (active pharmaceutical substances), food additives, herbal materials, natural medicaments, and naturally occurring substances that can have an effect on humans. The active ingredient can be any known agent adapted for therapeutic, prophylactic, or diagnostic use. These can include, for example, synthetic organic compounds, proteins and peptides, polysaccharides and other sugars, lipids, inorganic compounds, and nucleic acid sequences, having therapeutic, prophylactic, or diagnostic activity. Active ingredients include, but are not limited to, a nicotine component, botanical ingredients (e.g., lavender, peppermint, chamomile, basil, rosemary, ginger, cannabis, ginseng, maca, and tisanes), and/or cannabinoids, such as tetrahydrocannabinol (THC) and cannabidiol (CBD)). The particular percentages and choice of ingredients will vary depending upon the desired flavor, texture, and other characteristics. Example active ingredients would include any ingredient known to impact one or more biological functions within the body, such as ingredients that furnish pharmacological activity or other direct effect in the diagnosis, cure, mitigation, treatment, or prevention of disease, or which affect the structure or any function of the body of humans or other animals (e.g., provide a stimulating action on the central nervous system, have an energizing effect, an antipyretic or analgesic action, or an otherwise useful effect on the body).

The quantity of active ingredient present may vary, and when present, is generally less than about 30%, or less than about 20% by total weight of the substrate. For example, an active ingredient may be present in a quantity of from about 0.1%, about 0.5%, about 1%, or about 5%, to about 10%, about 20%, or about 30% by total weight of the substrate.

Herbal materials

In some embodiments, the active ingredient comprises one or more herbal materials. For the purposes of the present disclosure, the term "herbal materials" refers to seed-producing plants that do not develop persistent woody tissue and are often valued for their medicinal or sensory characteristics (e.g., teas or tisanes). Certain herbal materials, as the plant material or an extract thereof, have found use in traditional herbal medicine. Non-limiting examples of herbal materials or herbal-derived materials include hemp, eucalyptus, rooibos, fennel, citrus, cloves, lavender, peppermint, chamomile, basil, rosemary, ginger, turmeric, green tea, white mulberry, cannabis, cocoa, ashwagandha, baobab, chlorophyll, cordyceps, damiana, ginseng, guarana, and maca.

Nicotine component

In certain embodiments, the active ingredient comprises a naturally occurring or synthetic nicotine component. By "nicotine component" is meant any suitable form of nicotine (e.g., free base or salt) for providing oral absorption of at least a portion of the nicotine present. Nicotine may be tobacco-derived (e.g., a tobacco extract) or non-tobacco derived (e.g., synthetic or otherwise obtained). Most preferably, the nicotine is naturally occurring and obtained as an extract from a *Nicotiana* species (e.g., tobacco). The nicotine can have the enantiomeric form S(-)-nicotine, R(+)-nicotine, or a mixture of *S*(-)-nicotine and *R*(+)-nicotine. Most preferably, the nicotine is in the form of *S*(-)-nicotine (e.g., in a form that is virtually all S(-)-nicotine) or a racemic mixture composed primarily or predominantly of *S*(-)-nicotine (e.g., a mixture composed of about 95 weight parts *S*(-)-nicotine and about 5 weight parts *R*(+)-nicotine). Most preferably, the nicotine is employed in virtually pure form or in an essentially pure form. Highly preferred nicotine that is employed has a purity of greater than about 95 percent, more preferably greater than about 98 percent, and most preferably greater than about 99 percent, on a weight basis.

Typically, the nicotine component is selected from the group consisting of nicotine free base and a nicotine salt. In some embodiments, the nicotine component is nicotine in its free base form, which easily can be adsorbed in for example, a microcrystalline cellulose material to form a microcrystalline cellulose-nicotine carrier complex. See, for example, the discussion of nicotine in free base form in US Pat. Pub. No. 2004/0191322 to Hansson, which is incorporated herein by reference.

In some embodiments, at least a portion of the nicotine component can be employed in the form of a salt. Salts of nicotine can be provided using the types of ingredients and techniques set forth in US Pat. No. 2,033,909 to Cox et al. and Perfetti, *Beitrage Tabakforschung Int.*, 12: 43-54 (1983), which are incorporated herein by reference. Additionally, salts of nicotine are available from sources such as Pfaltz and Bauer, Inc. and K&K Laboratories, Division of ICN Biochemicals, Inc. Typically, the nicotine component is selected from the group consisting of nicotine free base, a nicotine salt such as hydrochloride, dihydrochloride, monotartrate, bitartrate, sulfate, salicylate, and nicotine zinc chloride.

In some embodiments, at least a portion of the nicotine can be in the form of a resin complex of nicotine, where nicotine is bound in an ion-exchange resin, such as nicotine polacrilex, which is nicotine bound to, for example, a polymethacrilic acid, such as Amberlite IRP64, Purolite C115HMR, or Doshion P551. See,

for example, US Pat. No. 3,901,248 to Lichtneckert et al., which is incorporated herein by reference. Another example is a nicotine-polyacrylic carbomer complex, such as with Carbopol 974P. In some embodiments, nicotine may be present in the form of a nicotine polyacrylic complex.

Typically, the nicotine component (calculated as the free base) when present, is in a concentration of at least about 0.001% by weight of the substrate, such as in a range from about 0.001% to about 10%, based on the total weight of the substrate. In some embodiments, the nicotine component is present in a concentration from about 0.1% w/w to about 10% by weight, such as, e.g., from about from about 0.1% w/w, about 0.2%, about 0.3%, about 0.4%, about 0.5% about 0.6%, about 0.7%, about 0.8%, or about 0.9%, to about 1%, about 2%, about 3%, about 4%, about 5%, about 6%, about 7%, about 8%, about 9%, or about 10% by weight, calculated as the free base and based on the total weight of the substrate. In some embodiments, the nicotine component is present in a concentration from about 0.1% w/w to about 3% by weight, such as, e.g., from about from about 0.1% w/w to about 2.5%, from about 0.1% to about 2.0%, from about 0.1% to about 1.5%, or from about 0.1% to about 1% by weight, calculated as the free base and based on the total weight of the substrate.

In some embodiments, the substrate of the disclosure can be characterized as completely free or substantially free of any nicotine component (e.g., any embodiment as disclosed herein may be completely or substantially free of any nicotine component). By "substantially free" is meant that no nicotine has been intentionally added, beyond trace amounts that may be naturally present in e.g., a botanical or herbal material. For example, certain embodiments can be characterized as having less than 0.001% by weight of nicotine, or less than 0.0001%, or even 0% by weight of nicotine, calculated as the free base, and based on the total weight of the substrate.

Cannabinoids

In some embodiments, the active ingredient comprises one or more cannabinoids. As used herein, the term "cannabinoid" refers to a class of diverse natural or synthetic chemical compounds that acts on cannabinoid receptors (e.g., CB1 and CB2) in cells that alter neurotransmitter release in the brain. Cannabinoids are cyclic molecules exhibiting particular properties such as the ability to easily cross the blood-brain barrier. Cannabinoids may be naturally occurring (Phytocannabinoids) from plants such as cannabis, (endocannabinoids) from animals, or artificially manufactured (synthetic cannabinoids).

Cannabis species express at least 85 different phytocannabinoids, and these may be divided into subclasses, including cannabigerols, cannabichromenes, cannabidiols, tetrahydrocannabinols, cannabinols and cannabinodiols, and other cannabinoids, such as cannabigerol (CBG), cannabichromene (CBC), cannabidiol (CBD), tetrahydrocannabinol (THC), cannabinol (CBN) and cannabinodiol (CBDL), cannabicyclol (CBL), cannabivarin (CBV), tetrahydrocannabivarin (THCV), cannabidivarin (CBDV), cannabichromevarin (CBCV), cannabigerovarin (CBGV), cannabigerol monomethyl ether (CBGM), cannabinerolic acid, cannabidiolic acid (CBDA), Cannabinol propyl variant (CBNV), cannabitriol (CBO), tetrahydrocannabmolic acid (THCA), and tetrahydrocannabivarinic acid (THCV A).

In some embodiments, the cannabinoid is selected from the group consisting of cannabigerol (CBG), cannabichromene (CBC), cannabidiol (CBD), tetrahydrocannabinol (THC), cannabinol (CBN) and cannabinodiol (CBDL), cannabicyclol (CBL), cannabivarin (CBV), tetrahydrocannabivarin (THCV), cannabidivarin (CBDV), cannabichromevarin (CBCV), cannabigerovarin (CBGV), cannabigerol monomethyl ether (CBGM), cannabinerolic acid, cannabidiolic acid (CBDA), Cannabinol propyl variant (CBNV), cannabitriol (CBO), tetrahydrocannabmolic acid (THCA), tetrahydrocannabivarinic acid (THCV A), and mixtures thereof.

In certain embodiments, the cannabinoid is selected from tetrahydrocannabinol (THC), the primary psychoactive compound in cannabis, and cannabidiol (CBD), another major constituent of the plant, but which is devoid of psychoactivity. All of the above compounds can be used in the form of an isolate from plant material or synthetically derived. Certain cannabinoids, including but not limited to CBD and THC, may exist in more than one isomeric form, for example □8- and □9-THC. Such isomeric forms may be naturally occurring or may be synthetic. For avoidance of doubt, reference within the present disclosure to a "cannabinoid" is intended to be inclusive of any and all isomeric forms thereof.

In some embodiments, the cannabinoid comprises at least tetrahydrocannabinol (THC). In some embodiments, the cannabinoid is tetrahydrocannabinol (THC). In some embodiments, the THC is □8-THC. In some embodiments, the THC is □9-THC.

In some embodiments, the cannabinoid comprises at least cannabidiol (CBD). In some embodiments, the cannabinoid is cannabidiol (CBD). In some embodiments, the CBD is synthetic CBD. In some embodiments, the CBD is □8-CBD. In some embodiments, the CBD is □9-CBD.

In some embodiments, the cannabinoid (e.g., CBD) is added to the substrate in the form of an isolate. An isolate is an extract from a plant, such as cannabis, where the active material of interest (in this case the cannabinoid, such as CBD) is present in a high degree of purity, for example greater than 95%, greater than 96%, greater than 97%, greater than 98%, or around 99% purity.

In some embodiments, the cannabinoid is an isolate of CBD in a high degree of purity, and the amount of any other cannabinoid in the oral product is no greater than about 1% by weight of the oral product, such as no greater than about 0.5% by weight of the oral product, such as no greater than about 0.1% by weight of the oral product, such as no greater than about 0.01% by weight of the oral product.

The choice of cannabinoid and the particular percentages thereof which may be present within the substrate. In some embodiments, the cannabinoid (such as CBD) is present in a concentration of at least about 0.001% by weight of the substrate, such as in a range from about 0.001% to about 2% by weight of the substrate. In some embodiments, the cannabinoid (such as CBD) is present in a concentration of from about 0.1% to about 1.5% by weight, based on the total weight of the substrate. In some embodiments, the cannabinoid (such as CBD) is present in a concentration from about 0.4% to about 1.5% by weight, based on the total weight of the substrate.

Alternatively, or in addition to the cannabinoid, the active ingredient may include a cannabimimetic, which is a class of compounds derived from plants other than cannabis that have biological effects on the

endocannabinoid system similar to cannabinoids. Examples include yangonin, alpha-amyrin or beta-amyrin (also classified as terpenes), cyanidin, curcumin (tumeric), catechin, quercetin, salvinorin A, N-acylethanolamines, and N-alkylamide lipids. Such compounds can be used in the same amounts and ratios noted herein for cannabinoids.

Flavorant

In some embodiments, the substrate as disclosed herein may comprise one or more flavorants, e.g., in the first substrate material, the second substrate material, or both. The flavorant may be independently selected for each of the first substrate material and second substrate material. As used herein, reference to a "flavorant" refers to compounds or components that can be aerosolized and delivered to a user and which impart a sensory experience in terms of taste and/or aroma. Some examples of flavorants include, but are not limited to, vanillin, ethyl vanillin, cream, tea, coffee, fruit (e.g., apple, cherry, strawberry, peach and citrus flavors, including lime and lemon), maple, menthol, mint, peppermint, spearmint, wintergreen, nutmeg, clove, lavender, cardamom, ginger, honey, anise, sage, rosemary, hibiscus, rose hip, yerba mate, guayusa, honeybush, rooibos, yerba santa, bacopa monniera, gingko biloba, withania somnifera, cinnamon, sandalwood, jasmine, cascarilla, cocoa, licorice, and flavorings and flavor packages of the type and character traditionally used for the flavoring of cigarette, cigar, and pipe tobaccos. In some embodiments, the flavorant comprises berry, clove, or citrus flavors and/or aromas.

Syrups, such as high fructose corn syrup, also can be employed. Some examples of plant-derived compositions that may be suitable are disclosed in U.S. Pat. No. 9,107,453 and U.S. Pat. App. Pub. No. 2012/0152265 both to Dube et al., the disclosures of which are incorporated herein by reference in their entireties. The selection of such further components is variable based upon factors such as the sensory characteristics that are desired for the smoking article, their affinity for the substrate material, their solubility, and other physiochemical properties. The present disclosure is intended to encompass any such further components that are readily apparent to those skilled in the art of tobacco and tobacco-related or tobacco-derived products. See, e.g., Gutcho, Tobacco Flavoring Substances and Methods, Noyes Data Corp. (1972) and Leffingwell et al., Tobacco Flavoring for Smoking Products (1972), the disclosures of which are incorporated herein by reference in their entireties. It should be noted that reference to a flavorant should not be limited to any single flavorant as described above, and may, in fact, represent a combination of one or more flavorants. Additional flavorants, flavoring agents, additives, and other possible enhancing constituents are described in U.S. Pat. App. Pub. No. 2019/0082735 to Phillips et al., which is incorporated herein by reference in its entirety.

The quantity of flavorant present may vary, and when present, is generally less than about 30%, or less than about 20% by weight of the substrate, based on the total weight of the substrate. For example, a flavorant may be present in a quantity of from about 0.1%, about 0.5%, about 1%, or about 5%, to about 10%, about 20%, or about 30% by weight of the substrate, based on the total wet weight of the substrate. In some embodiments, the flavorant is present in an amount from about 1 to about 5% by weight, or from about 1 to about 3% by weight, based on the total wet weight of the substrate.

Other Components

In some embodiments, the substrate may further comprise a burn retardant material, conductive fibers or particles for heat conduction/induction, or any combination thereof. One example of a burn retardant material is ammonium phosphate. In some embodiments, other flame/burn retardant materials and additives may be included within the substrate, and may include organo-phosphorus compounds, borax, hydrated alumina, graphite, potassium, silica, tripolyphosphate, dipentaerythritol, pentaerythritol, and polyols. Other burn retardant materials, such as nitrogenous phosphonic acid salts, mono-ammonium phosphate, ammonium polyphosphate, ammonium bromide, ammonium borate, ethanolammonium borate, ammonium sulphamate, halogenated organic compounds, thiourea, and antimony oxides may also be used. In each aspect of flame-retardant, burn-retardant, and/or scorch-retardant materials used in the substrate material and/or other components (whether alone or in combination with each other and/or other materials), the desirable properties are independent of and resistant to undesirable off-gassing or melting-type behavior. Various manners and methods for incorporating tobacco into smoking articles, and particularly smoking articles that are designed so as to not purposefully burn virtually all of the tobacco within those smoking articles are set forth in U.S. Pat. No. 4,947,874 to Brooks et al.; U.S. Pat. No. 7,647,932 to Cantrell et al.; U.S. Pat. No. 8,079,371 to Robinson et al.; U.S. Pat. No. 7,290,549 to Banerjee et al.; and U.S. Pat. App. Pub. No. 2007/0215167 to Crooks et al.; the disclosures of which are incorporated herein by reference in their entireties.

The substrate may also include conductive fibers or particles for heat conduction or heating by induction. In some embodiments, the conductive fibers or particles may be arranged in a substantially linear and parallel pattern. In some embodiments, the conductive fibers or particles may have a substantially random arrangement. In some embodiments, the conductive fibers or particles may be constructed of or more of an aluminum material, a stainless steel material, a copper material, a carbon material, and a graphite material. In some embodiments, one or more conductive fibers or particles with different Curie temperatures may be included in the substrate material to facilitate heating by induction at varying temperatures.

In still other implementations, the substrate material may comprise inorganic fibers of various types (e.g., fiber glass, metal wires/screens, etc.) and/or (organic) synthetic polymers. In various implementations, these "fibrous" materials could be unstructured (e.g., randomly distributed) or structured (e.g., a wire mesh).

Any of the foregoing other components may be included in the first substrate material, the second substrate material, or both. In addition to or in alternative of any of the foregoing other components may be combined (e.g., as a physical mixture) with the substrate.

First substrate material

The composite substrate as disclosed herein comprises a first substrate material. By "first substrate material" is meant a portion of the composite substrate to which a second substrate material is attached. The first substrate material comprises a filler, a binder, and an aerosol forming material, each as described herein above. The filler, binder, and aerosol forming material of the first substrate material are referred to as a first filler, a first binder, and a first aerosol forming material, respectively, in order to distinguish from the filler, binder, and

aerosol forming material of the second substrate material, each of which may be the same or different in each material.

The physical form of the first substrate material may vary. For example, in some embodiments, the first substrate material is in the form of a shredded or particulate material. In some embodiments, the first substrate material is in the form of a sheet.

The physical properties of the first substrate material (e.g., dimensions and density) may vary depending on physical form, components, and amounts thereof. In some embodiments, the first substrate material has a density in a range from 0.20 g/cm^3 to 1.2 g/cm^3. In some embodiments, the first substrate material has a thickness in a range from about 0.1 mm to about 1.5 mm.

The amount of the first filler present in the first substrate material may vary. In some embodiments, the first substrate material comprises at least about 50% by weight of the first filler, based on the total dry weight of the first substrate material. In some embodiments, first substrate material comprises from about 50% to about 75% by weight of the first filler, based on the total dry weight of the first substrate material, such as about 50, about 55, about 60, about 65, about 70, or about 75% by weight, based on the total dry weight of the first substrate material.

In some embodiments, the first filler comprises a tobacco material, a botanical material, wood pulp, a native or modified starch, maltodextrin, dextrose, calcium carbonate, a sugar alcohol, microcrystalline cellulose, or a combination thereof. In some embodiments, the first filler is selected from the group consisting of a tobacco material, wood pulp, maltodextrin, calcium carbonate, and combinations thereof. In some embodiments, the first filler is selected from the group consisting of wood pulp, maltodextrin, calcium carbonate, and combinations thereof.

In some embodiments, the first filler comprises a tobacco material, such as a milled tobacco. The quantity of tobacco material present in the first substrate material may vary, and is generally less than about 70% by weight of the first substrate material, based on the total dry weight of the first substrate material. For example, a tobacco material may be present in a quantity from about 30%, about 35%, about 40%, about 45%, or about 50%, to about 55%, about 60%, or about 65% by weight of the first substrate material, based on the total dry weight of the first substrate material. In some embodiments, the tobacco is present in an amount from about 30 to about 70% by weight, or from about 30 to about 50% by weight, based on the total dry weight of the first substrate material. In some embodiments, the tobacco is present in an amount from about 50 to about 65% by weight, based on the total dry weight of the first substrate material. In other embodiments, the first substrate material is substantially or completely free of tobacco material. By "substantially free" of tobacco material is meant that no tobacco material has been intentionally added, beyond trace amounts that may be naturally present in e.g., a botanical or other plant material. For example, certain embodiments may be characterized as having less than 0.1% by dry weight, or less than 0.01% by dry weight, or less than 0.001% by dry weight, or 0% by dry weight of tobacco material, based on the total dry weight of the first substrate material.

In some embodiments, the first filler comprises wood pulp. The quantity of wood pulp present in the first substrate material may vary, and is generally less than about 15% by weight of the first substrate material, based on the total dry weight of the first substrate material. For example, wood pulp may be present in a quantity from about 5 to about 10% by weight of the first substrate material, based on the total dry weight of the first substrate material. In other embodiments, the first substrate material is substantially or completely free of wood fibers or wood pulp. By "substantially free" of wood fibers or pulp is meant that no wood fibers or pulp have been intentionally added, beyond trace amounts that may be naturally present in e.g., a botanical or other plant material. For example, certain embodiments may be characterized as having less than 0.1% by dry weight, or less than 0.01% by dry weight, or less than 0.001% by dry weight, or 0% by dry weight of wood fibers or pulp, based on the total dry weight of the first substrate material.

In some embodiments, the first filler comprises calcium carbonate. The quantity of calcium carbonate may vary and is generally less than about 35% by weight of the first substrate material, based on the total dry weight of the first substrate material. For example, calcium carbonate may be present in a quantity of about 20, about 25, or about 30% by weight of the first substrate material, based on the total dry weight of the first substrate material.

In some embodiments, the first filler comprises:

a tobacco or botanical material in an amount from about 0 to about 70% by weight, based on the total wet weight of the first substrate material;

wood pulp in an amount from about 0 to about 10% by weight, based on the total wet weight of the first substrate material;

calcium carbonate in an amount from about 0 to about 30% by weight, based on the total wet weight of the first substrate material; and

maltodextrin in an amount from about 0 to about 40% by weight, based on the total wet weight of the first substrate material.

The amount of the first binder present in the first substrate material may vary. In some embodiments, the first substrate material comprises from about 5 to about 15% by weight of the first binder, based on the total wet weight of the first substrate material. In some embodiments, the first binder is a cellulose ether. In some embodiments, the cellulose ether is selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof. In some embodiments, the binder is CMC. In some embodiments, the first substrate material comprises about 5, about 6, about 7, about 8, about 9, about 10, about 11, about 12, about 13, about 14, or about 15% CMC by weight, based on the total wet weight of the first substrate material.

The amount of first aerosol forming material present in the first substrate material may vary. Generally, the amount of aerosol forming material that is present in the substrate as a whole is such that the substrate provides acceptable sensory and desirable performance characteristics. For example, in certain embodiments, sufficient amounts of aerosol forming material are employed in order to provide for the generation of a visible mainstream aerosol that in many regards resembles the appearance of tobacco smoke. The amount of aerosol

forming materials present may be dependent upon factors such as the number of puffs desired per aerosol generating component. The total quantity of aerosol forming material may be divided between the first substrate material and the second substrate material or may be present in only a single material.

In some embodiments, the first substrate material comprises the first aerosol forming material in an amount of about 20% by weight or less, such as about 5%, about 10%, about 15%, or about 20% by weight, based on a total wet weight of the first substrate material. In some embodiments, the first substrate material comprises the first aerosol forming material in an amount from about 10 to about 20% by weight, based on a total wet weight of the first substrate material.

In some embodiments, the first aerosol forming material comprises water, a polyhydric alcohol, a polysorbate, a sorbitan ester, a fatty acid, a fatty acid ester, a wax, a cannabinoid, a terpene, a sugar alcohol, or a combination thereof. In some embodiments, the first aerosol forming material comprises a polyhydric alcohol. In some embodiments, the polyhydric alcohol is selected from the group consisting of glycerin, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof. In some embodiments, the first aerosol forming material is glycerin.

In some embodiments, the first substrate material comprises:

a tobacco material in an amount from about 0 to about 70% by weight, based on the total wet weight of the first substrate material;

wood pulp in an amount from about 0 to about 10% by weight, based on the total wet weight of the first substrate material;

calcium carbonate in an amount from about 0 to about 30% by weight, based on the total wet weight of the first substrate material;

maltodextrin in an amount from about 0 to about 40% by weight, based on the total wet weight of the base material;

glycerin in an amount from about 10 to about 20% by weight, based on the total wet weight of the first substrate material;

carboxymethylcellulose in an amount from about 5 to about 15% by weight, based on the total wet weight of the first substrate material; and

water in an amount up to about 30% by weight, based on the total wet weight of the first substrate material.

In some embodiments, the first substrate material further comprises a flavorant, an active ingredient, a tobacco extract, or a combination thereof. In some embodiments, the active ingredient comprises a nicotine component.

Second substrate material

The composite substrate as disclosed herein comprises a second substrate material. By "second substrate material" is meant a portion of the composite substrate which is attached to the first substrate material. The second substrate material comprises a filler, a binder, and an aerosol forming material (i.e., a second filler, a second binder, and a second aerosol forming material so as to distinguish from the first instance of each), each as described herein above. In some embodiments, the first and second substrate may be the same material (i.e., having identical compositions), but are present in different form, for example, a cast sheet and one or more beads, spheres, rods, or the like.

The physical properties of the second substrate material (e.g., dimensions and density) may vary depending on physical form, components, and amounts thereof. In some embodiments, the second substrate material has a density in a range from about 0.5 g/cm^3 to about 0.8 g/cm^3, measured by the volume of a cylinder occupied by a given mass. In some embodiments, the density of the second substrate material is different from the density of the first substrate material. In some embodiments, the density of the first and second substrates varies by at least about 10%, such as about 10, about 15, or about 20%. In some embodiments, the density of the second substrate material is at least about 10% higher than the density of the first substrate material, such as about 10%, about 15%, or about 20% higher. Without wishing to be bound by any particular theory, it is believed that the composition and/or density differential between the first and the second substrate materials results in a slower aerosol formation from the denser substrate material, extending the duration of use from an article including such a composite substrate. For example, it is believed that, when incorporated into an aerosol delivery article as described herein, the composite substrate as disclosed herein results in an extended and more pleasurable consumer experience (e.g., longer and more consistent aerosol formation) relative to that obtained in use of a conventional article not having the composite substrate.

The physical form of the second substrate material may vary. For example, in some embodiments, the second substrate material is in the form of a shredded or particulate material. In some embodiments, the second substrate material is in the form of a sheet. In some embodiments, the second substrate material is in the form of one or more beads, spheres, or rods. In some embodiments, the second substrate material is in the form of one or more beads (a "beaded material") which are adhered to, or imbedded within, the first substrate material. By "beaded material" is meant that the material is in the form of granules or pellets that can have any of a variety of cross-sectional shapes, including rounded, spherical, ovoid, or irregular shapes. The beaded material is typically flowable such that the beaded material can be readily deposited e.g., onto a sheet of first substrate material. In some embodiments, the beads are rounded or spherical. In some embodiments, the beads are between #32 and #4 mesh. In some embodiments, the beads have a diameter in a range from about 0.5 mm to about 5 mm, such as about 0.5, about 1, about 2, about 3, about 4, or about 5 mm. In some embodiments, the beads are roughly spherical.

The amount of the second filler present in the second substrate material may vary. In some embodiments, the second substrate material comprises at least about 50% by weight of the second filler, based

on the total wet weight of the second substrate material. In some embodiments, second substrate material comprises from about 50% to about 75% by weight of the second filler, based on the total wet weight of the second substrate material, such as about 50, about 55, about 60, about 65, about 70, or about 75% by weight, based on the total wet weight of the second substrate material. In some embodiments, the second substrate material comprises from about 50% to about 65% by weight of the second filler, based on the total wet weight of the second substrate material.

In some embodiments, the second filler comprises a tobacco material, a botanical material, calcium carbonate, or a combination thereof. In some embodiments, the second filler is selected from the group consisting of a tobacco material, calcium carbonate, and combinations thereof.

In some embodiments, the second filler comprises a tobacco material, for example, a milled tobacco material. The quantity of tobacco material present in the second substrate material may vary and is generally less than about 50% by weight of the second substrate material, based on the total wet weight of the second substrate material. For example, a tobacco material may be present in a quantity from about 20%, about 25%, about 30%, or about 35%, to about 40%, about 45%, or about 50% by weight of the second substrate material, based on the total wet weight of the second substrate material. In some embodiments, the tobacco material is present in an amount from about 20 to about 40% by weight, or from about 25 to about 35% by weight, based on the total wet weight of the second substrate material.

In some embodiments, the second filler comprises calcium carbonate. The quantity of calcium carbonate may vary and is generally less than about 50% by weight of the second substrate material, based on the total wet weight of the second substrate material. For example, calcium carbonate may be present in a quantity of about 20, about 25, about 30, about 35, or about 40% by weight of the second substrate material, based on the total wet weight of the second substrate material.

In some embodiments, the second filler comprises:

a tobacco material in an amount from about 20 to about 40% by weight, based on the total wet weight of the second substrate material; and

calcium carbonate in an amount from about 20 to about 40% by weight, based on the total wet weight of the second substrate material.

In some embodiments, the second substrate material further comprises a binder (i.e., the second binder). The amount of second binder present in the second substrate material may vary. In some embodiments, the second substrate material comprises less than about 5% by weight of second binder, based on the total wet weight of the second substrate material. In some embodiments, the second substrate material comprises about 0.1% to about 2%, such as about 0.5 to about 1% of second binder by weight, based on the wet weight of the second substrate material. In some embodiments, the amount of binder present in the second substrate material is less than that present in the first substrate material.

In some embodiments, the second binder is selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof. In some embodiments, the second binder is a

cellulose ether. In some embodiments, the cellulose ether is selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof. In some embodiments, the second binder is CMC. In some embodiments, the second substrate material comprises from about 0.5 to about 2% CMC by weight, based on the total wet weight of the second substrate material.

In some embodiments, the second substrate material further comprises a second aerosol forming material. When present, the amount of second aerosol forming material present in the second substrate material may vary. In some embodiments, the second substrate material comprises the second aerosol forming material in an amount of about 20% by weight or less, such as about 5%, about 10%, about 15%, or about 20% by weight, based on a total wet weight of the second substrate material. In some embodiments, the second substrate material comprises the second aerosol forming material in an amount from about 10 to about 20% by weight, based on a total wet weight of the second substrate material.

In some embodiments, the second aerosol forming material comprises water, a polyhydric alcohol, a polysorbate, a sorbitan ester, a fatty acid, a fatty acid ester, a wax, a cannabinoid, a terpene, a sugar alcohol, or a combination thereof. In some embodiments, the second aerosol forming material comprises a polyhydric alcohol. In some embodiments, the polyhydric alcohol is selected from the group consisting of glycerin, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof. In some embodiments, the aerosol forming material is glycerin.

The amount of water present in the second substrate material may vary. For example, in some embodiments, the second substrate material comprises from about 0.1 to about 50% water by weight, based on the total wet weight of the second substrate material. In some embodiments, the second substrate material is dried to remove at least a portion of the water present during preparation. In some embodiments, after drying, the second substrate material comprises less than about 10% water, such as about 5%, about 1%, or about 0.1% by weight, based on the total wet weight of the second substrate material.

In some embodiments, the second substrate material comprises:

a tobacco material in an amount from about 20 to about 40% by weight, based on the total dry weight of the second substrate material;

calcium carbonate in an amount from about 20 to about 40% by weight, based on the total dry weight of the second substrate material;

glycerin in an amount from about 0 to about 20% by weight, based on the total dry weight of the second substrate material; and

carboxymethylcellulose in an amount from about 0 to about 2% by weight, based on the total dry weight of the second substrate material.

In some embodiments, the second substrate material further comprises a flavorant, an active ingredient, or a combination thereof. In some embodiments, the second substrate material comprises from about 10 to about 50% by weight of flavorant, based on the total wet weight of the second substrate material. Any flavorant or active ingredient, when present in the second substrate material, may be the same or different from any flavorant

or active agent present in the first substrate material. In some embodiments, the first substrate material and the second substrate material each comprise a flavorant. In particular embodiments, the flavorant is different in each of the first substrate material and the second substrate material.

II. Preparation of the Composite Substrate

First substrate material

The first substrate material which comprises the composite substrate may be prepared in various ways. In some embodiments, the first substrate material may be prepared using cast sheet technology to make the first substrate material in the form of a flat sheet. The preparative method generally comprises producing a first substrate material mixture comprising a first filler, a first binder, water, and a first aerosol forming material; and casting the slurry onto a supportive device or surface to form a wet sheet. For example, in some embodiments the first substrate material components as disclosed herein may be blended together to form a slurry, which may be cast onto a surface (such as, for example, a moving belt, band or screen). For example, the slurry is cast, or otherwise coated, at the desired thickness onto a moving impervious metal belt. The cast slurry may then experience one or more drying and/or doctoring steps such that the result is a cast sheet of relatively consistent thickness. Other examples of casting and paper-making techniques are set forth in U.S. Pat. No. 4,674,519 to Keritsis et al.; U.S. Pat. No. 4,941,484 to Clapp et al.; U.S. Pat. No. 4,987,906 to Young et al.; U.S. Pat. No. 4,972,854 to Kiernan et al.; U.S. Pat. No. 5,099,864 to Young et al.; U.S. Pat. No. 5,143,097 to Sohn et al.; U.S. Pat. No. 5,159,942 to Brinkley et al.; U.S. Pat. No. 5,322,076 to Brinkley et al.; U.S. Pat. No. 5,339,838 to Young et al.; U.S. Pat. No. 5,377,698 to Litzinger et al.; U.S. Pat. No. 5,501,237 to Young; and U.S. Pat. No. 6,216,706 to Kumar; the disclosures of which is incorporated herein by reference in their entireties.

Generally, the first substrate material components as disclosed herein are combined to form a mixture. The manner by which the various components (e.g., filler, binder, water, and the like) are combined may vary. For example, the filler and binder may be added to water, or water may be added to the filler and binder to create slurry. In some embodiments, further components are added, such as active ingredients, flavorants, aerosol generating components, and the like. To be clear, reference throughout the application to "added" or "adding" should not be construed as limiting with respect to the manner in which the various components are brought into contact with one another. For example, the components noted above, which may be in liquid or dry solid form, can be admixed in a pretreatment step prior to mixture with any remaining components, or simply mixed together with all other liquid or dry ingredients. Any individual component of the first substrate material may be added to any other first substrate material components, either individually or in any combination.

The specific components utilized and the proportion of the various components may vary, and is dependent upon the intended form and use of the first substrate material. In some embodiments, the specific components and quantities of each are as disclosed herein with respect to the first substrate material embodiments. In some embodiments, the method of preparing the first substrate material in the form of a cast sheet comprises combining a filler material comprising a tobacco material, calcium carbonate, wood pulp,

maltodextrin, or combinations thereof with a binder, water, and an aerosol forming material. In some embodiments, the binder is a cellulose ether, such as carboxymethylcellulose. In some embodiments, the aerosol forming material is glycerin. In addition to serving as an aerosol forming material, glycerin may also act as a humectant which enhances sheet pliability. In some embodiments, glycerin is slowly added to calcium carbonate and mixed prior to combining with the additional components (e.g., water, binder, and milled tobacco material, wood pulp, maltodextrin, or combinations thereof). In some embodiments, the method comprises mixing carboxymethylcellulose with water in a vessel to create a carboxymethylcellulose slurry; adding the carboxymethylcellulose slurry to the calcium carbonate-glycerin slurry; and mixing the carboxymethylcellulose slurry and the calcium carbonate-glycerol slurry. The remaining components (e.g., tobacco material, wood pulp, maltodextrin, or combinations thereof) may be added to the slurry, or the slurry may be added to the remaining components, either individually or as a preformed mixture of any thereof.

The various components of the first substrate material may be contacted, combined, or mixed together using any mixing technique or equipment known in the art. Any mixing method that brings the first substrate material components into intimate contact can be used, such as a mixing apparatus featuring an impeller or other structure capable of agitation. Examples of mixing equipment include casing drums, conditioning cylinders or drums, liquid spray apparatus, conical-type blenders, ribbon blenders, mixers available as FKM130, FKM600, FKM1200, FKM2000 and FKM3000 from Littleford Day, Inc., Plough Share types of mixer cylinders, Hobart mixers, and the like. See also, for example, the types of methodologies set forth in US Pat. Nos. 4,148,325 to Solomon et al.; 6,510,855 to Korte et al.; and 6,834,654 to Williams, each of which is incorporated herein by reference. Manners and methods for formulating mixtures will be apparent to those skilled in the art. See, for example, the types of methodologies set forth in US Pat. No. 4,148,325 to Solomon et al.; US Pat. No. 6,510,855 to Korte et al.; and US Pat. No. 6,834,654 to Williams, US Pat. Nos. 4,725,440 to Ridgway et al., and 6,077,524 to Bolder et al., each of which is incorporated herein by reference.

The mixing times and speeds can vary to suit a particular application. The various mixing steps can be at moderate and/or variable speeds (e.g., from about 50-500 RPM, such as from about 75-150 RPM). The various mixing steps can last from about 5 minutes to 60 minutes, such as about 15 minutes to 45 minutes or about 30 minutes.

In some embodiments, casting the first substrate material mixture comprises casting the final slurry of the first substrate material mixture onto the support surface using a casting knife set at about a 1 to 3 mm gap opening. In some embodiments, the first substrate material is used directly in the form of a wet sheet. In other embodiments, the wet sheet is solidified. In some embodiments, solidifying the wet sheet comprises drying the cast first substrate material mixture by heating.

Second substrate material

The second substrate material which comprises the composite substrate may be prepared in various ways. The specific components utilized and the proportion of the various components may vary, and is dependent upon the intended use of the second substrate material. In some embodiments, the specific

components and the quantities of each component are as disclosed herein with respect to the second substrate material.

In some embodiments, the second substrate material is in the form of a sheet. In such embodiments, the components of the second substrate material are combined and processed to form a sheet as described with respect to the first substrate material.

In some embodiments, the second substrate material is in the form of beads, spheres, rods, or the like. In some embodiments, the second substrate material is in the form of beads. Generally, the second substrate material in beaded or rod form as disclosed herein may be prepared using extrusion and spheronization technology. As a non-limiting example description, the second substrate material in beaded or rod form disclosed herein may be prepared by combining the individual second substrate material components (e.g., the second filler, second binder, water, and the like), to form a slurry, extruding the slurry, and spheronizing the extrudate.

In some embodiments, the method of preparing the second substrate material in beaded form comprises combining a filler material comprising a milled tobacco material and calcium carbonate with water, an aerosol forming material, or a combination thereof. In some embodiments, the method further comprises adding a binder. In some embodiments, the binder is a cellulose ether, such as carboxymethylcellulose. In some embodiments, further components are added, such as active ingredients, flavorants, or both.

Generally, the second substrate material components as disclosed herein are combined to form a slurry. The manner by which the various components are combined may vary. Any of the noted components, which may be in liquid or dry solid form, can be admixed in a pretreatment step prior to mixture with any remaining components, or simply mixed together with all other liquid or dry ingredients. Any individual component of the second substrate material may be added to any other second substrate material components, either individually or in any combination. The various components of the second substrate material may be contacted, combined, or mixed together using any mixing technique or equipment known in the art as noted above with respect to the base material. Similarly, mixing times and speeds may vary.

In some embodiments, second substrate material components are granulated (agglomerized). Granulation is the process in which the primary powder particles of the individual components are made to adhere to form large, homogenous, multi-particle entities called granules. Any suitable means for granulation may be employed. For example, granulation can be conducted under high-shear, low-shear, fluid bed, rotor, or melt granulation.

After the second substrate material components have been combined to form a slurry or have been granulated, the slurry or agglomerate is then extruded. The extrusion can be carried out using extruders such as screw, sieve, basket, roll, and ram-type extruders, extruding the slurry or agglomerate through suitably sized pierced screens. Any suitable extrudate shape may be used. In some embodiments, the slurry or agglomerate is extruded into rods.

The extrudate is then subjected to spheronization or marumerization to produce round or ovoid shaped beads. Accordingly, in some embodiments, the method further comprises portioning the second substrate material mixture; transferring a portion of the second substrate material mixture to an extruder to form rods of the substrate mixture; and transferring at least a portion of the extruded rods to a marumerizer to form rounded beads of the second substrate material mixture. In some embodiments, the extrudate is processed in a spheronizer (e.g., such as spheronizers available from Caleva Process Solutions Ltd. or LCI Corporation) at a suitable rotation speed (e.g., 1200 RPM) for a suitable time (e.g., 10 minutes). For example, spheronization can be carried out using a spinning friction plate that effects rounding of extrudate particles.

The beads may optionally be dried to remove at least a portion of the liquid content (e.g., water). The resulting beads may be dried in fluid bed dryers, apron dryers, rotary dryers, flash dryers, tray dryers or plow mixers. The final moisture content may be from about 3-20% moisture by weight on a wet basis.

Following the optional drying, the variously sized beads can be processed through a series of screens to provide the desired size range. Additionally, flavorants, extracts, aerosol forming materials, and the like can be added to the beads after drying.

Composite substrate

To form the composite substrate as disclosed herein, the second substrate material is attached to the first substrate material. In some embodiments, the first substrate material and the second substrate material are in the form of sheets and are attached together in a layered configuration.

In some embodiments, the first substrate material is in the form of a sheet, and the second substrate material is in the form of one or more beads adhered to, or imbedded within, the first substrate material. In such embodiments, generally, the second substrate material in the form of beads is deposited onto the surface of the first substrate material in the form of a cast sheet. The second substrate material is deposited on the surface of the first substrate material sheet using any suitable means, such as a doser. In some embodiments, the beads are deposited by hot application by doser, dropping the beads onto the first substrate material sheet as it moves down a conveyor line. The quantity of beads deposited may vary, such as a single bead or a plurality of beads. The quantity of beads present may be expressed as a percentage by weight of the composite substrate. For example, the composite substrate may comprise the beaded material in an amount by weight from about 10 to about 70%, such as about 10, about 20, about 30, about 40, about 50, about 60, or about 70% by weight, based on the total weight of the composite substrate. In some embodiments, the composite substrate comprises the beaded material in an amount by weight from about 10 to about 50, or about 20 to about 40% by weight, based on the total weight of the substrate.

The beaded material may be applied to the surface of the first substrate material in a random pattern or in a uniform pattern. In some embodiments, the beaded material is randomly deposited (i.e., scattered) without regard to spacing or application density. In some embodiments, the beaded material is deposited in a uniform

manner, such that the distribution of beads is regular with regard to spacing. For example, the beaded material may be deposited in lines or rows, the lines or rows in alignment with one another or offset from one another.

Following the depositing of the beaded material, the wet sheet having deposited thereon the beaded material may be dried, adhering the beaded material to the base material to form the composite substrate. The wet sheet is generally dried to the desired moisture level. Drying may be provided using a variety of techniques. For example, the wet sheet can be (i) air dried under ambient conditions, (ii) heated on a heated metal surface, (iii) subjected to contact with heated air, or (iv) heated on a heated metal surface and subjected to contact with heated air.

In some embodiments, the composite substrate may be coated or laminated, before or after drying, so as to avoid loss of the beaded material during later processing (e.g., cutting). For example, in some embodiments, the composite substrate is in a layered form, having the beaded material embedded between layers of the first substrate material. To provide such embodiments, a second layer of first substrate material slurry is cast onto the initial layer of first substrate material having the beaded material disposed thereon or adhered thereto. This second layer may be applied either before or after drying the initial layer of first substrate material having the beaded material disposed thereon or adhered thereto. The layered composite substrate is then dried as described above, forming a layered composite substrate with the beaded material embedded therein.

In some embodiments, the method further comprises removing the composite substrate from the support surface, and optionally, winding the composite substrate on a bobbin.

The final form of the composite substrate may vary. In some embodiments, the composite substrate is in the form of a flat sheet, a gathered sheet, multiple layered sheets, a rolled sheet, or in shredded form. In some embodiments, the composite substrate is in flat sheet form. In some embodiments, the flat sheet is layered, for example, in a series of overlapping layers. FIG. 3 illustrates a perspective schematic view of an aerosol generating component according to an example embodiment of the disclosure. In particular, FIG. 3 illustrates an aerosol generating component **104** having a substrate portion **110** that comprises a series of overlapping layers **130** of a substrate as disclosed herein in sheet form **120**. In the depicted embodiment, the substrate sheet **120** comprises a layer of first substrate material having adhered thereto a plurality of beads, each as disclosed herein.

In some embodiments, the flat sheet may be bunched, crumpled, crimped, and/or otherwise gathered layers. The flat sheet may also be gathered or rolled into rod for insertion into the substrate-containing segment (aerosol generating component) of an aerosol delivery device.

In some embodiments, the size of the composite substrate may be reduced for inserting into the substrate-containing segment of an aerosol delivery device. In some embodiments, reducing the size comprises cutting the composite substrate into strips or shredding the composite substrate. Accordingly, in some embodiments, the method of preparing the composite substrate further comprises cutting the composite substrate into a plurality of strips, the dimensions of which may vary.

In some embodiments, the composite substrate may be combined with additional materials. For example, the composite substrate may be combined with a tobacco material, including a reconstituted tobacco material ("recon" tobacco), or with an aerosol generating material, or both, each as described herein above. For example, in some embodiments, one or more aerosol forming materials may be sprayed or otherwise disposed in or on the composite substrate material. Methods for loading (e.g., impregnating) aerosol forming material into or onto substrate portions are described in U.S. Pat. No. 9,974,334 to Dooly et al., and U.S. Pub. Pat. App. Nos. 2015/0313283 to Collett et al. and 2018/0279673 to Sebastian et al., the disclosures of which are incorporated by reference herein in their entirety. The additional materials (e.g., tobacco material, a non-tobacco material, or both) may be combined with the composite substrate in other arrangements. For example, tobacco material may be combined with the beaded material, non-tobacco material may be combined with the cast sheet, or any permutation or combination thereof.

III. Aerosol Generating Components and Aerosol Delivery Devices

A composite substrate according to embodiments of the disclosure can be used in aerosol delivery devices or the aerosol generating components thereof. Accordingly, further example embodiments of the present disclosure relate to an aerosol delivery device comprising an aerosol generating component comprising the substrate as disclosed herein; a heat source configured to heat the aerosol forming materials carried in the substrate portion to form an aerosol; and an aerosol pathway extending from the aerosol generating component to a mouth-end of the aerosol delivery device. The individual components and construction of the aerosol generating component and aerosol delivery device are provided herein below.

Aerosol generating components of certain example aerosol delivery devices may provide many of the sensations (e.g., inhalation and exhalation rituals, types of tastes or flavors, organoleptic effects, physical feel, use rituals, visual cues such as those provided by visible aerosol, and the like) of smoking a cigarette, cigar or pipe that is employed by lighting and burning tobacco (and hence inhaling tobacco smoke), without any substantial degree of combustion of any component thereof. For example, the user of an aerosol delivery device in accordance with some example embodiments of the present disclosure can hold and use that component much like a smoker employs a traditional type of smoking article, draw on one end of that piece for inhalation of aerosol produced by that piece, take or draw puffs at selected intervals of time, and the like.

While the systems are generally described herein in terms of embodiments associated with aerosol delivery devices and/or aerosol generating components such as so-called "e-cigarettes" or "tobacco heating products," it should be understood that the mechanisms, components, features, and methods may be embodied in many different forms and associated with a variety of articles. For example, the description provided herein may be employed in conjunction with embodiments of traditional smoking articles (e.g., cigarettes, cigars, pipes, etc.), heat-not-burn cigarettes, and related packaging for any of the products disclosed herein. Accordingly, it should be understood that the description of the mechanisms, components, features, and methods disclosed herein are discussed in terms of embodiments relating to aerosol delivery devices by way of example only, and may be embodied and used in various other products and methods.

Aerosol delivery devices and/or aerosol generating components of the present disclosure may also be characterized as being vapor-producing articles or medicament delivery articles. Thus, such articles or devices may be adapted so as to provide one or more substances (e.g., flavors and/or pharmaceutical active ingredients) in an inhalable form or state. For example, inhalable substances may be substantially in the form of a vapor (i.e., a substance that is in the gas phase at a temperature lower than its critical point). Alternatively, inhalable substances may be in the form of an aerosol (i.e., a suspension of fine solid particles or liquid droplets in a gas). For purposes of simplicity, the term "aerosol" as used herein is meant to include vapors, gases and aerosols of a form or type suitable for human inhalation, whether or not visible, and whether or not of a form that might be considered to be smoke-like. The physical form of the inhalable substance is not necessarily limited by the nature of the inventive devices but rather may depend upon the nature of the medium and the inhalable substance itself as to whether it exists in a vapor state or an aerosol state. In some embodiments, the terms "vapor" and "aerosol" may be interchangeable. Thus, for simplicity, the terms "vapor" and "aerosol" as used to describe aspects of the disclosure are understood to be interchangeable unless stated otherwise.

More specific formats, configurations and arrangements of various substrate materials, aerosol generating components, and components within aerosol delivery devices of the present disclosure will be evident in light of the further disclosure provided hereinafter. Additionally, the selection of various aerosol delivery device components may be appreciated upon consideration of the commercially available electronic aerosol delivery devices. Further, the arrangement of the components within the aerosol delivery device may also be appreciated upon consideration of the commercially available electronic aerosol delivery devices.

A substrate according to certain embodiments of the disclosure can be used in aerosol generating segments of heat-not-burn (HNB) devices, which use an ignitable heat source to heat a material (generally without combusting the material to any significant degree) to form an inhalable substance (e.g., carbon heated tobacco products). The material is typically heated without combusting the material to any significant degree. See, for example, US Patent App. Pub. Nos. 2017/0065000 to Sears et al.; 2015/0157052 to Ademe et al.; US Pat. Nos. 10,314,330 to Conner et al.; 9,345,268 to Stone et al.; 9,149,072 to Conner et al.; 5,105,831 and 5,042,509, both to Banerjee et al., each of which is incorporated herein by reference. Components of such systems have the form of articles that are sufficiently compact to be considered hand-held devices. That is, use of components of certain example aerosol delivery devices does not result in the production of smoke in the sense that aerosol results principally from by-products of combustion or pyrolysis of tobacco, but rather, use of those systems results in the production of vapors resulting from volatilization or vaporization of certain components incorporated therein.

Accordingly, in some embodiments, aerosol generating components of the present disclosure may generally include an ignitable heat source configured to heat a substrate material as disclosed herein to aerosolize an aerosol forming material associated with the substrate material, forming an inhalable substance. The substrate material and/or at least a portion of the heat source may be covered in an outer wrap, or wrapping, a casing, a component, a module, a member, or the like. The overall design of the enclosure is variable, and the

format or configuration of the enclosure that defines the overall size and shape of the aerosol generating component is also variable. Although other configurations are possible, it may be desirable, in some aspects, that the overall design, size, and/or shape of these embodiments resemble that of a conventional cigarette or cigar.

A substrate according to certain embodiments of the disclosure can be used in aerosol generating components of aerosol delivery devices which use electrical energy to heat a substrate material as disclosed herein to aerosolize an aerosol forming material associated with the substrate material, forming an inhalable substance (e.g., electrically heated tobacco products). In some example embodiments, the aerosol delivery devices may be characterized as electronic cigarettes. Accordingly, in some embodiments, aerosol delivery devices of the present disclosure may comprise some combination of a power source (e.g., an electrical power source), at least one control component (e.g., means for actuating, controlling, regulating and ceasing power for heat generation, such as by controlling electrical current flow from the power source to other components of the article, e.g., a microprocessor, individually or as part of a microcontroller), a heat source (e.g., an electrical resistance heating element or other component and/or an inductive coil or other associated components and/or one or more radiant heating elements), and an aerosol generating component that includes a substrate portion as disclosed herein, capable of yielding an aerosol upon application of sufficient heat. Note that it is possible to physically combine one or more of the above-noted components. For instance, in certain embodiments, a conductive heater trace can be printed on the surface of a substrate material as described herein (e.g., a cellulosic film) using a conductive ink such that the heater trace can be powered by the power source and used as the resistance heating element. Example conductive inks include graphene inks and inks containing various metals, such as inks including silver, gold, palladium, platinum, and alloys or other combinations thereof (e.g., silver-palladium or silver-platinum inks), which can be printed on a surface using processes such as gravure printing, flexographic printing, off-set printing, screen printing, ink-jet printing, or other appropriate printing methods.

In various embodiments, a number of these components may be provided within an outer body or shell, which, in some embodiments, may be referred to as a housing. The overall design of the outer body or shell may vary, and the format or configuration of the outer body that may define the overall size and shape of the aerosol delivery device may vary. Although other configurations are possible, in some embodiments an elongated body resembling the shape of a cigarette or cigar may be a formed from a single, unitary housing or the elongated housing can be formed of two or more separable bodies. For example, an aerosol delivery device may comprise an elongated shell or body that may be substantially tubular in shape and, as such, resemble the shape of a conventional cigarette or cigar. In one example, all of the components of the aerosol delivery device are contained within one housing or body. In other embodiments, an aerosol delivery device may comprise two or more housings that are joined and are separable. For example, an aerosol delivery device may possess at one end a control body comprising a housing containing one or more reusable components (e.g., an accumulator such as a rechargeable battery and/or rechargeable supercapacitor, and various electronics for controlling the operation of that article), and at the other end and removably coupleable thereto, an outer body or shell containing a disposable portion (e.g., a disposable flavor-containing aerosol generating component).

Aerosol generating components and aerosol delivery devices comprising the substrate as disclosed herein and using either heat from combustion or heat from electrical energy to provide an aerosol therefrom, are described further herein below with reference to FIGS. 1-6.

In this regard, FIG. 1 illustrates an aerosol delivery device **100** according to an example embodiment of the present disclosure. The aerosol delivery device **100** may include a control body **102** and an aerosol generating component **104**. In some embodiments, the aerosol generating component is configured for use with a conductive and/or inductive heat source to heat a substrate material to form an aerosol. In various embodiments, a conductive heat source may comprise a heating assembly that comprises a resistive heating member. Resistive heating members may be configured to produce heat when an electrical current is directed therethrough. Electrically conductive materials useful as resistive heating members may be those having low mass, low density, and moderate resistivity and that are thermally stable at the temperatures experienced during use. Useful heating members heat and cool rapidly, and thus provide for the efficient use of energy. Rapid heating of the member may be beneficial to provide almost immediate volatilization of an aerosol forming materials in proximity thereto. Rapid cooling prevents substantial volatilization (and hence waste) of the aerosol forming materials during periods when aerosol formation is not desired. Such heating members may also permit relatively precise control of the temperature range experienced by the aerosol forming materials, especially when time based current control is employed. Useful electrically conductive materials are typically chemically non-reactive with the materials being heated (e.g., aerosol forming materials and other inhalable substance materials) so as not to adversely affect the flavor or content of the aerosol or vapor that is produced. Some example, non-limiting, materials that may be used as the electrically conductive material include carbon, graphite, carbon/graphite composites, metals, ceramics such as metallic and non-metallic carbides, nitrides, oxides, silicides, inter-metallic compounds, cermets, metal alloys, and metal foils. In particular, refractory materials may be useful. Various, different materials can be mixed to achieve the desired properties of resistivity, mass, and thermal conductivity. In specific embodiments, metals that can be utilized include, for example, nickel, chromium, alloys of nickel and chromium (e.g., nichrome), and steel. Materials that can be useful for providing resistive heating are described in U.S. Pat. No. 5,060,671 to Counts et al.; U.S. Pat. Nos. 5,093,894 to Deevi et al.; 5,224,498 to Deevi et al.; 5,228,460 to Sprinkel Jr., et al.; 5,322,075 to Deevi et al.; U.S. Pat. No. 5,353,813 to Deevi et al.; U.S. Pat. No. 5,468,936 to Deevi et al.; U.S. Pat. No. 5,498,850 to Das; U.S. Pat. No. 5,659,656 to Das; U.S. Pat. No. 5,498,855 to Deevi et al.; U.S. Pat. No. 5,530,225 to Hajaligol; U.S. Pat. No. 5,665,262 to Hajaligol; U.S. Pat. No. 5,573,692 to Das et al.; and U.S. Pat. No. 5,591,368 to Fleischhauer et al., the disclosures of which are incorporated herein by reference in their entireties.

In various embodiments, a heating member may be provided in a variety of forms, such as in the form of a foil, a foam, a mesh, a hollow ball, a half ball, discs, spirals, fibers, wires, films, yarns, strips, ribbons, or cylinders. Such heating members often comprise a metal material and are configured to produce heat as a result of the electrical resistance associated with passing an electrical current therethrough. Such resistive heating members may be positioned in proximity to, and/or in direct contact with, the substrate portion. For example, in one embodiment, a heating member may comprise a cylinder or other heating device located in the control body

102, wherein the cylinder is constructed of one or more conductive materials, including, but not limited to, copper, aluminum, platinum, gold, silver, iron, steel, brass, bronze, carbon (e.g., graphite), or any combination thereof. In various embodiments, the heating member may also be coated with any of these or other conductive materials. The heating member may be located proximate an engagement end of the control body **102** and may be configured to substantially surround a portion of the heated end **106** of the aerosol generating component **104** that includes the substrate portion **110**. In such a manner, the heating member may be located proximate the substrate portion **110** of the aerosol generating component **104** when the aerosol generating component **104** is inserted into the control body **102**. In other examples, at least a portion of a heating member may penetrate at least a portion of an aerosol generating component (such as, for example, one or more prongs and/or spikes that penetrate an aerosol generating component), when the aerosol generating component is inserted into the control body. Although in some embodiments the heating member may comprise a cylinder, it should be noted that in other embodiments, the heating member may take a variety of forms and, in some embodiments, may make direct contact with and/or penetrate the substrate portion. As described above, in addition to being configured for use with a conductive heat source, the presently disclosed aerosol generating component may also be configured for use with an inductive heat source to heat a substrate portion to form an aerosol. In various embodiments, an inductive heat source may comprise a resonant transformer, which may comprise a resonant transmitter and a resonant receiver (e.g., a susceptor). In some embodiments, the resonant transmitter and the resonant receiver may be located in the control body **102**. In other embodiments, the resonant receiver, or a portion thereof, may be located in the aerosol generating component **104**. For example, in some embodiments, the control body **102** may include a resonant transmitter, which, for example, may comprise a foil material, a coil, a cylinder, or other structure configured to generate an oscillating magnetic field, and a resonant receiver, which may comprise one or more prongs that extend into the substrate portion or are surrounded by the substrate portion. In some embodiments, the aerosol generating component is in intimate contact with the resonant receiver.

In other embodiments, a resonant transmitter may comprise a helical coil configured to circumscribe a cavity into which an aerosol generating component, and in particular, a substrate portion of an aerosol generating component, is received. In some embodiments, the helical coil may be located between an outer wall of the device and the receiving cavity. In one embodiment, the coil winds may have a circular cross section shape; however, in other embodiments, the coil winds may have a variety of other cross section shapes, including, but not limited to, oval shaped, rectangular shaped, L-shaped, T-shaped, triangular shaped, and combinations thereof. In another embodiment, a pin may extend into a portion of the receiving cavity, wherein the pin may comprise the resonant transmitter, such as by including a coil structure around or within the pin. In various embodiments, an aerosol generating component may be received in the receiving cavity wherein one or more components of the aerosol generating component may serve as the resonant receiver. In some embodiments, the aerosol generating component comprises the resonant receiver. Other possible resonant transformer components, including resonant transmitters and resonant receivers, are described in U.S. Pat. App. Pub. No. 2019/0124979 to Sebastian et al., which is incorporated herein by reference in its entirety.

In various embodiments, the aerosol generating component **104** and the control body **102** may be permanently or detachably aligned in a functioning relationship. In this regard, FIG. 1 illustrates the aerosol delivery device **100** in a coupled configuration, whereas FIG. 2 illustrates the aerosol delivery device **100** in a decoupled configuration. Various mechanisms may connect the aerosol generating component **104** to the control body **102** to result in a threaded engagement, a press-fit engagement, an interference fit, a sliding fit, a magnetic engagement, or the like.

In various embodiments, the aerosol delivery device **100** according to an example embodiment of the present disclosure may have a variety of overall shapes, including, but not limited to an overall shape that may be defined as being substantially rod-like or substantially tubular shaped or substantially cylindrically shaped. In the embodiments of FIGS. 1-2, the device **100** has a substantially round cross-section; however, other cross-sectional shapes (e.g., oval, square, triangle, etc.) also are encompassed by the present disclosure. For example, in some embodiments one or both of the control body **102** or the aerosol generating component **104** (and/or any subcomponents) may have a substantially rectangular shape, such as a substantially rectangular cuboid shape (e.g., similar to a USB flash drive). In other embodiments, one or both of the control body **102** or the aerosol generating component **104** (and/or any subcomponents) may have other hand-held shapes. For example, in some embodiments the control body **102** may have a small box shape, various pod mod shapes, or a fob-shape. Thus, such language that is descriptive of the physical shape of the article may also be applied to the individual components thereof, including the control body **102** and the aerosol generating component **104**.

Alignment of the components within the aerosol delivery device of the present disclosure may vary across various embodiments. In some embodiments, the substrate portion may be positioned proximate a heat source so as to maximize aerosol delivery to the user. Other configurations, however, are not excluded. Generally, the heat source may be positioned sufficiently near the substrate portion so that heat from the heat source can volatilize the substrate portion (e.g., the aerosol forming material therein) and form an aerosol for delivery to the user. When the heat source heats the substrate portion, an aerosol is formed, released, or generated in a physical form suitable for inhalation by a consumer. It should be noted that the foregoing terms are meant to be interchangeable such that reference to release, releasing, releases, or released includes form or generate, forming or generating, forms or generates, and formed or generated. Specifically, an inhalable substance is released in the form of a vapor or aerosol or mixture thereof, wherein such terms are also interchangeably used herein except where otherwise specified.

As noted above, the aerosol delivery device **100** of various embodiments may incorporate a battery and/or other electrical power source to provide current flow sufficient to provide various functionalities to the aerosol delivery device, such as powering of the heat source, powering of control systems, powering of indicators, and the like. As will be discussed in more detail below, the power source may take on various embodiments. The power source may be able to deliver sufficient power to rapidly activate the heat source to provide for aerosol formation and power the aerosol delivery device through use for a desired duration of time. In some embodiments, the power source is sized to fit conveniently within the aerosol delivery device so that the

aerosol delivery device can be easily handled. Examples of useful power sources include lithium-ion batteries that are typically rechargeable (e.g., a rechargeable lithium-manganese dioxide battery). In particular, lithium polymer batteries can be used as such batteries can provide increased safety. Other types of batteries – e.g., N50-AAA CADNICA nickel-cadmium cells – may also be used. Additionally, an example power source is of a sufficiently light weight to not detract from a desirable smoking experience. Some examples of possible power sources are described in U.S. Pat. No. 9,484,155 to Peckerar et al., and U.S. Pat. App. Pub. No. 2017/0112191 to Sur et al., the disclosures of which are incorporated herein by reference in their respective entireties.

In specific embodiments, one or both of the control body **102** and the aerosol generating component **104** may be referred to as being disposable or as being reusable. For example, the control body **102** may have a replaceable battery or a rechargeable battery, solid-state battery, thin-film solid-state battery, rechargeable supercapacitor or the like, and thus may be combined with any type of recharging technology, including connection to a wall charger, connection to a car charger (i.e., cigarette lighter receptacle), and connection to a computer, such as through a universal serial bus (USB) cable or connector (e.g., USB 2.0, 3.0, 3.1, USB Type-C), connection to a photovoltaic cell (sometimes referred to as a solar cell) or solar panel of solar cells, a wireless charger, such as a charger that uses inductive wireless charging (including for example, wireless charging according to the Qi wireless charging standard from the Wireless Power Consortium (WPC)), or a wireless radio frequency (RF) based charger. An example of an inductive wireless charging system is described in U.S. Pat. App. Pub. No. 2017/0112196 to Sur et al., which is incorporated herein by reference in its entirety. Further, in some embodiments, the aerosol generating component **104** may comprise a single-use device. A single use component for use with a control body is disclosed in U.S. Pat. No. 8,910,639 to Chang et al., which is incorporated herein by reference in its entirety.

In further embodiments, the power source may also comprise a capacitor. Capacitors are capable of discharging more quickly than batteries and can be charged between puffs, allowing the battery to discharge into the capacitor at a lower rate than if it were used to power the heat source directly. For example, a supercapacitor – e.g., an electric double-layer capacitor (EDLC) – may be used separate from or in combination with a battery. When used alone, the supercapacitor may be recharged before each use of the article. Thus, the device may also include a charger component that can be attached to the smoking article between uses to replenish the supercapacitor.

Further components may be utilized in the aerosol delivery device of the present disclosure. For example, the aerosol delivery device may include a flow sensor that is sensitive either to pressure changes or air flow changes as the consumer draws on the article (e.g., a puff-actuated switch). Other possible current actuation/deactuation mechanisms may include a temperature actuated on/off switch or a lip pressure actuated switch. An example mechanism that can provide such puff-actuation capability includes a Model 163PC01D36 silicon sensor, manufactured by the MicroSwitch division of Honeywell, Inc., Freeport, Ill. Representative flow sensors, current regulating components, and other current controlling components including various microcontrollers, sensors, and switches for aerosol delivery devices are described in U.S. Pat. No. 4,735,217 to

Gerth et al., U.S. Pat. Nos. 4,922,901, 4,947,874, and 4,947,875, all to Brooks et al., U.S. Pat. No. 5,372,148 to McCafferty et al., U.S. Pat. No. 6,040,560 to Fleischhauer et al., U.S. Pat. No. 7,040,314 to Nguyen et al., and U.S. Pat. No. 8,205,622 to Pan, all of which are incorporated herein by reference in their entireties. Reference is also made to the control schemes described in U.S. Pat. No. 9,423,152 to Ampolini et al., which is incorporated herein by reference in its entirety.

In another example, an aerosol delivery device may comprise a first conductive surface configured to contact a first body part of a user holding the device, and a second conductive surface, conductively isolated from the first conductive surface, configured to contact a second body part of the user. As such, when the aerosol delivery device detects a change in conductivity between the first conductive surface and the second conductive surface, a vaporizer is activated to vaporize a substance so that the vapors may be inhaled by the user holding unit. The first body part and the second body part may be a lip or parts of a hand(s). The two conductive surfaces may also be used to charge a battery contained in the personal vaporizer unit. The two conductive surfaces may also form, or be part of, a connector that may be used to output data stored in a memory. Reference is made to U.S. Pat. No. 9,861,773 to Terry et al., which is incorporated herein by reference in its entirety.

In addition, U.S. Pat. No. 5,154,192 to Sprinkel et al. discloses indicators for smoking articles; U.S. Pat. No. 5,261,424 to Sprinkel, Jr. discloses piezoelectric sensors that can be associated with the mouth-end of a device to detect user lip activity associated with taking a draw and then trigger heating of a heating device; U.S. Pat. No. 5,372,148 to McCafferty et al. discloses a puff sensor for controlling energy flow into a heating load array in response to pressure drop through a mouthpiece; U.S. Pat. No. 5,967,148 to Harris et al. discloses receptacles in a smoking device that include an identifier that detects a non-uniformity in infrared transmissivity of an inserted component and a controller that executes a detection routine as the component is inserted into the receptacle; U.S. Pat. No. 6,040,560 to Fleischhauer et al. describes a defined executable power cycle with multiple differential phases; U.S. Pat. No. 5,934,289 to Watkins et al. discloses photonic-optronic components; U.S. Pat. No. 5,954,979 to Counts et al. discloses means for altering draw resistance through a smoking device; U.S. Pat. No. 6,803,545 to Blake et al. discloses specific battery configurations for use in smoking devices; U.S. Pat. No. 7,293,565 to Griffen et al. discloses various charging systems for use with smoking devices; U.S. Pat. No. 8,402,976 to Fernando et al. discloses computer interfacing means for smoking devices to facilitate charging and allow computer control of the device; U.S. Pat. No. 8,689,804 to Fernando et al. discloses identification systems for smoking devices; and PCT Pat. App. Pub. No. WO 2010/003480 by Flick discloses a fluid flow sensing system indicative of a puff in an aerosol generating system; all of the foregoing disclosures being incorporated herein by reference in their entireties.

Further examples of components related to electronic aerosol delivery articles and disclosing materials or components that may be used in the present device include U.S. Pat. No. 4,735,217 to Gerth et al.; U.S. Pat. No. 5,249,586 to Morgan et al.; U.S. Pat. No. 5,666,977 to Higgins et al.; U.S. Pat. No. 6,053,176 to Adams et al.; U.S. Pat. No. 6,164,287 to White; U.S. Pat No. 6,196,218 to Voges; U.S. Pat. No. 6,810,883 to Felter et al.;

U.S. Pat. No. 6,854,461 to Nichols; U.S. Pat. No. 7,832,410 to Hon; U.S. Pat. No. 7,513,253 to Kobayashi; U.S. Pat. No. 7,896,006 to Hamano; U.S. Pat. No. 6,772,756 to Shayan; U.S. Pat. Nos. 8,156,944 and 8,375,957 to Hon; U.S. Pat. No. 8,794,231 to Thorens et al.; U.S. Pat. No. 8,851,083 to Oglesby et al.; U.S. Pat. Nos. 8,915,254 and 8,925,555 to Monsees et al.; U.S. Pat. No. 9,220,302 to DePiano et al.; U.S. Pat. App. Pub. Nos. 2006/0196518 and 2009/0188490 to Hon; U.S. Pat. App. Pub. No. 2010/0024834 to Oglesby et al.; U.S. Pat. App. Pub. No. 2010/0307518 to Wang; PCT Pat. App. Pub. No. WO 2010/091593 to Hon; and PCT Pat. App. Pub. No. WO 2013/089551 to Foo, each of which is incorporated herein by reference in its entirety. Further, U.S. Pat. App. Pub. No. 2017/0099877 to Worm et al. discloses capsules that may be included in aerosol delivery devices and fob-shape configurations for aerosol delivery devices, and is incorporated herein by reference in its entirety. A variety of the materials disclosed by the foregoing documents may be incorporated into the present devices in various embodiments, and all of the foregoing disclosures are incorporated herein by reference in their entireties.

Referring to FIG. 2, in the depicted embodiment, the aerosol generating component **104** comprises a heated end **106**, which is configured to be inserted into the control body **102**, and a mouth end **108**, upon which a user draws to create the aerosol. At least a portion of the heated end **106** includes a substrate portion **110**. In some embodiments, the substrate portion **110** comprises a substrate comprising the aerosol forming material, each as disclosed herein. In various embodiments, the aerosol generating component **104**, or a portion thereof, may be wrapped in an exterior overwrap material **112**. In various embodiments, the mouth end **108** of the aerosol generating component **104** may include a filter **114**, which may, for example, be made of a cellulose acetate or polypropylene material. The filter **114** may additionally or alternatively contain strands of tobacco containing material, such as described in U.S. Pat. No. 5,025,814 to Raker et al., which is incorporated herein by reference in its entirety. In various embodiments, the filter **114** may increase the structural integrity of the mouth end of the aerosol generating component **104**, and/or provide filtering capacity, if desired, and/or provide resistance to draw. In some embodiments, the filter may comprise discrete segments. For example, some embodiments may include a segment providing filtering, a segment providing draw resistance, a hollow segment providing a space for the aerosol to cool, a segment providing increased structural integrity, other filter segments, and any one or any combination of the above.

In some embodiments, the material of the exterior overwrap **112** may comprise a material that resists transfer of heat, which may include a paper or other fibrous material, such as a cellulose material. The exterior overwrap material may also include at least one filler material imbedded or dispersed within the fibrous material. In various embodiments, the filler material may have the form of water insoluble particles. Additionally, the filler material may incorporate inorganic components. In various embodiments, the exterior overwrap may be formed of multiple layers, such as an underlying, bulk layer and an overlying layer, such as a typical wrapping paper in a cigarette. Such materials may include, for example, lightweight "rag fibers" such as flax, hemp, sisal, rice straw, and/or esparto. The exterior overwrap may also include a material typically used in a filter element of a conventional cigarette, such as cellulose acetate. Further, an excess length of the exterior overwrap at the mouth end **108** of the aerosol generating component may function to simply separate the

substrate portion **110** from the mouth of a consumer or to provide space for positioning of a filter material, as described below, or to affect draw on the article or to affect flow characteristics of the vapor or aerosol leaving the device during draw. Further discussions relating to the configurations for exterior overwrap materials that may be used with the present disclosure may be found in U.S. Pat. No. 9,078,473 to Worm et al., which is incorporated herein by reference in its entirety.

Although in some embodiments an aerosol generating component and a control body may be provided together as a complete aerosol delivery article generally, the components may be provided separately. For example, the present disclosure also encompasses a disposable unit for use with a reusable smoking article or a reusable pharmaceutical delivery article. In specific embodiments, such a disposable unit (which may be an aerosol generating component as illustrated in the appended figures) can comprise a substantially tubular shaped body having a heated end configured to engage the reusable aerosol delivery article, an opposing mouth end configured to allow passage of an inhalable substance to a consumer, and a wall with an outer surface and an inner surface that defines an interior space. Various embodiments of an aerosol generating component (or cartridge) are described in U.S. Pat. No. 9,078,473 to Worm et al., which is incorporated herein by reference in its entirety.

Although some figures described herein illustrate the control body and aerosol generating component in a working relationship, it is understood that the control body and the aerosol generating component may exist as individual devices. Accordingly, any discussion otherwise provided herein in relation to the components in combination also should be understood as applying to the control body and the aerosol generating component as individual and separate components.

In another aspect, the present disclosure may be directed to kits that provide a variety of components as described herein. For example, a kit may comprise a control body with one or more aerosol generating components. A kit may further comprise a control body with one or more charging components. A kit may further comprise a control body with one or more batteries. A kit may further comprise a control body with one or more aerosol generating components and one or more charging components and/or one or more batteries. In further embodiments, a kit may comprise a plurality of aerosol generating components. A kit may further comprise a plurality of aerosol generating components and one or more batteries and/or one or more charging components. In the above embodiments, the aerosol generating components or the control bodies may be provided with a heating member inclusive thereto. The inventive kits may further include a case (or other packaging, transporting, or storage component) that accommodates one or more of the further kit components. The case could be a reusable hard or soft container. Further, the case could be simply a box or other packaging structure.

FIG. 3 illustrates a perspective schematic view of an aerosol generating component according to an example embodiment of the disclosure. In particular, FIG. 3 illustrates the aerosol generating component **104** having a substrate portion **110** that comprises a series of overlapping layers **130** of a substrate as disclosed

herein in sheet form **120**. In various embodiments, the term "overlapping layers" may also include bunched, crumpled, crimped, and/or otherwise gathered layers in which the individual layers may not be obvious.

FIG. 4 illustrates a schematic cross-section drawing of a substrate portion of an aerosol generating component according to an example embodiment of the present disclosure. In particular, FIG. 4 illustrates the substrate portion **110**, which comprises a series of overlapping layers **130** of the substrate sheet **120**. In the depicted embodiment, at least a portion of the overlapping layers **130** is substantially surrounded about its outer surface with a first cover layer **132**. Although in various embodiments the composition of the first cover layer **132** may vary, in the depicted embodiment the first cover layer **132** comprises a combination of a fibrous material, the aerosol forming materials, and a binder material. Reference is made to the discussions herein relating to possible aerosol forming materials and binder materials. In various embodiments, the first cover layer **132** may be constructed via a casting process, such as that described in U.S. Pat. No. 5,697,385 to Seymour et al., the disclosure of which is incorporated herein by reference in its entirety. In the depicted embodiment, at least a portion of the overlapping layers **130** and the first cover layer **132** are substantially surrounded about an outer surface with a second cover layer **134**. Although the composition of the second cover layer **134** may vary, in the depicted embodiment the second cover layer **134** comprises a metal foil material, such as an aluminum foil material. In other embodiments, the second cover layer may comprise other materials, including, but not limited to, a copper material, a tin material, a gold material, an alloy material, a ceramic material, or other thermally conductive amorphous carbon-based material, and/or any combinations thereof. The depicted embodiment further includes a third cover layer **136**, which substantially surrounds the overlapping layers **130**, first cover layer **132**, and the second cover layer **134**, about an outer surface thereof. In the depicted embodiment, the third cover layer **136** comprises a paper material, such as a conventional cigarette wrapping paper. In various embodiments, the paper material may comprise rag fibers, such as non-wood plant fibers, and may include flax, hemp, sisal, rice straw, and/or esparto fibers.

In various embodiments, other components may exist between the substrate portion **110** and the mouth end **108** of the aerosol generating component **104**. For example, in some embodiments one or any combination of the following may be positioned between the substrate portion **110** and the mouth end **108** of the aerosol generating component **104**: an air gap; a hollow tube structure; phase change materials for cooling air; flavor releasing media; ion exchange fibers capable of selective chemical adsorption; aerogel particles as filter medium; and other suitable materials. Some examples of possible phase change materials include, but are not limited to, salts, such as $AgNO_3$, $AlCl_3$, $TaCl_3$, $InCl_3$, $SnCl_2$, AlI_3, and TiI_4; metals and metal alloys such as selenium, tin, indium, tin-zinc, indium-zinc, or indium-bismuth; and organic compounds such as D-mannitol, succinic acid, p-nitrobenzoic acid, hydroquinone and adipic acid. Other examples are described in U.S. Pat. No. 8,430,106 to Potter et al., which is incorporated herein by reference in its entirety.

FIG. 5 illustrates a perspective view of an aerosol generating component, according to another example embodiment of the present disclosure, and FIG. 6 illustrates a perspective view of the aerosol generating component of FIG. 5 with an outer wrap removed. In particular, FIG. 5 illustrates an aerosol generating

component **200** that includes an outer wrap **202**, and FIG. 6 illustrates the aerosol generating component **200** wherein the outer wrap **202** is removed to reveal the other components of the aerosol generating component **200**. In the depicted embodiment, the aerosol generating component **200** of the depicted embodiment includes a heat source **204**, a substrate portion **210**, an intermediate component **208**, and a filter **212**. In the depicted embodiment, the intermediate component **208** and the filter **212** together comprise a mouthpiece **214**.

In various embodiments, the heat source **204** may be configured to generate heat upon ignition thereof. In the depicted embodiment, the heat source **204** comprises a combustible fuel element that has a generally cylindrical shape and that incorporates a combustible carbonaceous material. In other embodiments, the heat source **204** may have a different shape, for example, a prism shape having a triangular, cubic or hexagonal cross-section. Carbonaceous materials generally have a high carbon content. Certain example carbonaceous materials may be composed predominately of carbon, and/or typically may have carbon contents of greater than about 60 percent, generally greater than about 70 percent, often greater than about 80 percent, and frequently greater than about 90 percent, on a dry weight basis.

In some instances, the heat source **204** may incorporate elements other than combustible carbonaceous materials (e.g., tobacco components, such as powdered tobaccos or tobacco extracts; flavoring agents; salts, such as sodium chloride, potassium chloride and sodium carbonate; heat stable graphite fibers; iron oxide powder; glass filaments; powdered calcium carbonate; alumina granules; ammonia sources, such as ammonia salts; binding agents, such as guar gum, ammonium alginate and sodium alginate; and/or phase change materials for lowering the temperature of the heat source, described herein above). Although specific dimensions of an applicable heat source may vary, in some embodiments, the heat source **204** may have a length in an inclusive range of approximately 7 mm to approximately 20 mm, and in some embodiments may be approximately 17 mm, and an overall diameter in an inclusive range of approximately 3 mm to approximately 8 mm, and in some embodiments may be approximately 4.8 mm (and in some embodiments, approximately 7 mm). Although in other embodiments, the heat source may be constructed in a variety of ways, in the depicted embodiment, the heat source **204** is extruded or compounded using a ground or powdered carbonaceous material, and has a density that is greater than about 0.5 g/cm^3, often greater than about 0.7 g/cm^3, and frequently greater than about 1 g/cm^3, on a dry weight basis. See, for example, the types of fuel source components, formulations and designs set forth in U.S. Pat. No. 5,551,451 to Riggs et al. and U.S. Pat. No. 7,836,897 to Borschke et al., which are incorporated herein by reference in their entireties. Although in various embodiments, the heat source may have a variety of forms, including, for example, a substantially solid cylindrical shape or a hollow cylindrical (e.g., tube) shape, the heat source **204** of the depicted embodiment comprises an extruded monolithic carbonaceous material that has a generally cylindrical shape but with a plurality of grooves **216** extending longitudinally from a first end of the extruded monolithic carbonaceous material to an opposing second end of the extruded monolithic carbonaceous material. In some embodiments, the aerosol delivery device, and in particular, the heat source, may include a heat transfer component. In various embodiments, a heat transfer component may be proximate the heat source, and, in some embodiments, a heat transfer component may be located in or within the heat source. Some examples of heat transfer components are

described in in U.S. Pat. App. Pub. No. 2019/0281891 to Hejazi et al., which is incorporated herein by reference in its entirety.

Although in the depicted embodiment, the grooves **216** of the heat source **204** are substantially equal in width and depth and are substantially equally distributed about a circumference of the heat source **204**, other embodiments may include as few as two grooves, and still other embodiments may include as few as a single groove. Still other embodiments may include no grooves at all. Additional embodiments may include multiple grooves that may be of unequal width and/or depth, and which may be unequally spaced around a circumference of the heat source. In still other embodiments, the heat source may include flutes and/or slits extending longitudinally from a first end of the extruded monolithic carbonaceous material to an opposing second end thereof. In some embodiments, the heat source may comprise a foamed carbon monolith formed in a foam process of the type disclosed in U.S. Pat. No. 7,615,184 to Lobovsky, which is incorporated herein by reference in its entirety. As such, some embodiments may provide advantages with regard to reduced time taken to ignite the heat source. In some other embodiments, the heat source may be co-extruded with a layer of insulation (not shown), thereby reducing manufacturing time and expense. Other embodiments of fuel elements include carbon fibers of the type described in U.S. Pat. No. 4,922,901 to Brooks et al. or other heat source embodiments such as is disclosed in U.S. Pat. App. Pub. No. 2009/0044818 to Takeuchi et al., each of which is incorporated herein by reference in its entirety.

Generally, the heat source is positioned sufficiently near a substrate portion carrying one or more aerosol forming materials so that the aerosol formed/volatilized by the application of heat from the heat source to the aerosol forming materials (as well as any flavorants, medicaments, and/or the like that are likewise provided for delivery to a user) is deliverable to the user by way of the mouthpiece. That is, when the heat source heats the substrate portion, an aerosol is formed, released, or generated in a physical form suitable for inhalation by a consumer. It should be noted that the foregoing terms are meant to be interchangeable such that reference to release, releasing, releases, or released includes form or generate, forming or generating, forms or generates, and formed or generated. Specifically, an inhalable substance is released in the form of a vapor or aerosol or mixture thereof.

Referring back to FIG. 5 and FIG. 6, the outer wrap **202** may be provided to engage or otherwise join together at least a portion of the heat source **204** with the substrate portion **210** and at least a portion of the mouthpiece **214**. In various embodiments, the outer wrap **202** is configured to be retained in a wrapped position in any manner of ways including via an adhesive, or a fastener, and the like, to allow the outer wrap **202** to remain in the wrapped position. Otherwise, in some other aspects the outer wrap **202** may be configured to be removable as desired. For example, upon retaining the outer wrap **202** in a wrapped position, the outer wrap **202** may be able to be removed from the heat source **204**, the substrate portion **210**, and/or the mouthpiece **214**.

In some embodiments, in addition to the outer wrap **202**, the aerosol delivery device may also include a liner that is configured to circumscribe the substrate portion **210** and at least a portion of the heat source **204**. Although in other embodiments the liner may circumscribe only a portion of the length of the substrate portion

210, in some embodiments, the liner may circumscribe substantially the full length of the substrate portion **210**. In some embodiments, the outer wrap material **202** may include the liner. As such, in some embodiments the outer wrap material **202** and the liner may be separate materials that are provided together (e.g., bonded, fused, or otherwise joined together as a laminate). In other embodiments, the outer wrap **202** and the liner may be the same material. In any event, the liner may be configured to thermally regulate conduction of the heat generated by the ignited heat source **204**, radially outward of the liner. As such, in some embodiments, the liner may be constructed of a metal foil material, an alloy material, a ceramic material, or other thermally conductive amorphous carbon-based material, and/or an aluminum material, and in some embodiments may comprise a laminate. In some embodiments, depending on the material of the outer wrap **202** and/or the liner, a thin layer of insulation may be provided radially outward of the liner. Thus, the liner may advantageously provide, in some aspects a manner of engaging two or more separate components of the aerosol generating component **200** (such as, for example, the heat source **204**, the substrate portion **210**, and/or a portion of the mouthpiece **214**), while also providing a manner of facilitating heat transfer axially therealong, but restricting radially outward heat conduction.

As shown in FIG. 5, the outer wrap **202** (and, as necessary, the liner, and the substrate portion **210**) may also include one or more openings formed therethrough that allow the entry of air upon a draw on the mouthpiece **214**. In various embodiments, the size and number of these openings may vary based on particular design requirements. In the depicted embodiment, a plurality of openings **220** are located proximate an end of the substrate portion **210** closest to the heat source **204**, and a plurality of separate cooling openings **221** are formed in the outer wrap **202** (and, in some embodiments, the liner) in an area proximate the filter **212** of the mouthpiece **214**. Although other embodiments may differ, in the depicted embodiment, the openings **220** comprise a plurality of openings substantially evenly spaced about the outer surface of the aerosol generating component **200**, and the openings **221** also comprise a plurality of openings substantially evenly spaced around the outer surface of the aerosol generating component **200**. Although in various embodiments the plurality of openings may be formed through the outer wrap **202** (and, in some embodiments, the liner) in a variety of ways, in the depicted embodiment, the plurality of openings **220** and the plurality of separate cooling openings **221** are formed via laser perforation.

Referring back to FIG. 6, the aerosol generating component **200** of the depicted implementation also includes an intermediate component **208** and at least one filter **212**. It should be noted that in various implementations, the intermediate component **208** or the filter **212**, individually or together, may be considered a mouthpiece **214** of the aerosol generating component **200**. Although in various implementations, neither the intermediate component nor the filter need be included, in the depicted implementation the intermediate component **208** comprises a substantially rigid member that is substantially inflexible along its longitudinal axis. In the depicted implementation, the intermediate component **208** comprises a hollow tube structure, and is included to add structural integrity to the aerosol generating component **200** and provide for cooling the produced aerosol. In some implementations, the intermediate component **208** may be used as a container for collecting the aerosol. In various implementations, such a component may be constructed from any of a variety

of materials and may include one or more adhesives. Example materials include, but are not limited to, paper, paper layers, paperboard, plastic, cardboard, and/or composite materials. In the depicted implementation, the intermediate component **208** comprises a hollow cylindrical element constructed of a paper or plastic material (such as, for example, ethyl vinyl acetate (EVA), or other polymeric materials such as poly ethylene, polyester, silicone, etc. or ceramics (e.g., silicon carbide, alumina, etc.), or other acetate fibers), and the filter comprises a packed rod or cylindrical disc constructed of a gas permeable material (such as, for example, cellulose acetate or fibers such as paper or rayon, or polyester fibers).

As noted, in some implementations the mouthpiece **214** may comprise a filter **212** configured to receive the aerosol therethrough in response to the draw applied to the mouthpiece **214**. In various implementations, the filter **212** is provided, in some aspects, as a circular disc radially and/or longitudinally disposed proximate the second end of the intermediate component **208**. In this manner, upon draw on the mouthpiece **214**, the filter **212** receives the aerosol flowing through the intermediate component **208** of the aerosol generating component **200**. In some implementations, the filter **212** may comprise discrete segments. For example, some implementations may include a segment providing filtering, a segment providing draw resistance, a hollow segment providing a space for the aerosol to cool, a segment providing increased structural integrity, other filter segments, and any one or any combination of the above. In some implementations, the filter **212** may additionally or alternatively contain strands of tobacco containing material, such as described in U.S. Pat. No. 5,025,814 to Raker et al., which is incorporated herein by reference in its entirety.

In various implementations the size and shape of the intermediate component **208** and/or the filter **212** may vary, for example the length of the intermediate component **208** may be in an inclusive range of approximately 10 mm to approximately 30 mm, the diameter of the intermediate component **208** may be in an inclusive range of approximately 3 mm to approximately 8 mm, the length of the filter **212** may be in an inclusive range of approximately 10 mm to approximately 20 mm, and the diameter of the filter **212** may be in an inclusive range of approximately 3 mm to approximately 8 mm. In the depicted implementation, the intermediate component **208** has a length of approximately 20 mm and a diameter of approximately 4.8 mm (and in some implementations, approximately 7 mm), and the filter **212** has a length of approximately 15 mm and a diameter of approximately 4.8 mm (or in some implementations, approximately 7 mm).

In various implementations, ignition of the heat source **204** results in aerosolization of the aerosol forming materials associated with the substrate portion **210**. In certain embodiments, the elements of the substrate portion **210** do not experience thermal decomposition (e.g., charring, scorching, or burning) to any significant degree, and the aerosolized components are entrained in the air that is drawn through the aerosol generating component **200**, including the filter **212**, and into the mouth of the user. In various implementations, the mouthpiece **214** (e.g., the intermediate component **208** and/or the filter **212**) is configured to receive the generated aerosol therethrough in response to a draw applied to the mouthpiece **214** by a user. In some implementations, the mouthpiece **214** may be fixedly engaged to the substrate portion **210**. For example, an adhesive, a bond, a weld, and the like may be suitable for fixedly engaging the mouthpiece **214** to the substrate

portion **210**. In one example, the mouthpiece **214** is ultrasonically welded and sealed to an end of the substrate portion **210**.

Although an aerosol deliver device and/or an aerosol generating component according to the present disclosure may take on a variety of embodiments, as discussed in detail above, the use of the aerosol delivery device and/or aerosol generating component by a consumer will be similar in scope. The foregoing description of use of the aerosol delivery device and/or aerosol generating component is applicable to the various embodiments described through minor modifications, which are apparent to the person of skill in the art in light of the further disclosure provided herein. The description of use, however, is not intended to limit the use of the articles of the present disclosure but is provided to comply with all necessary requirements of disclosure herein.

Many modifications and other embodiments of the disclosure will come to mind to one skilled in the art to which this disclosure pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the disclosure is not to be limited to the specific embodiments disclosed herein and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

EXAMPLES

Aspects of the present invention are more fully illustrated by the following examples, which are set forth to illustrate certain aspects of the present invention and are not to be construed as limiting thereof.

Example 1. Cast sheet base material embodiment-milled tobacco

An example of a cast sheet base material embodiment of the disclosure was prepared according to the formula provided in Table 1. The actual ingredients and percentages can be varied depending on the desired properties of the final product.

A slurry was prepared by mixing enough water and carboxymethylcellulose (CMC) in a high shear mixer untill the CMC was fully hydrated, providing a 2-2.5% (w/v) solution. To the slurry was added glycerin followed by mixing. Tobacco and calcium carbonate were subsequently added and mixed to obtain a final slurry. The slurry was then cast onto a 22-inch-wide stainless steel conveyer belt by decanting the slurry from a headbox through ~~using~~ a casting or draw knife with a 1-3 mm x 22-inch wide opening. The conveyer belt was passed through a forced air oven with drying zones set at 100-200°C, to obtain a cast sheet at 8-12% final moisture.

Table 1: Formulation of milled tobacco base material sheet embodiment

Component	wt%, dry basis
water	N/A
milled tobacco	40
calcium carbonate	30
glycerin	21

Component	wt%, dry basis
carboxymethylcellulose	9

Example 2. Cast sheet base material embodiment-milled tobacco

Another example of a cast sheet base material embodiment of the disclosure was prepared according to the formula provided in Table 2. The actual ingredients and percentages can be varied depending on the desired properties of the final product.

A slurry was prepared and cast onto a conveyor belt as described in Example 1 above, except that calcium carbonate was not used in the formulation.

Table 2: Formulation of milled tobacco base material sheet embodiment

Component	wt%, dry basis
water	N/A
milled tobacco	56
glycerin	21
carboxymethylcellulose	8

Example 3. Cast sheet base material embodiment-milled tobacco and wood pulp

Another example of a cast sheet base material embodiment of the disclosure was prepared according to the formula provided in Table 3, using the general procedure of Examples 1 and 2, except that a wood pulp solution was added to the hydrated CMC slurry and mixed before the addition of tobacco and calcium carbonate. The actual ingredients and percentages can be varied depending on the desired properties of the final product.

Table 3: Formulation of milled tobacco-wood pulp base material sheet embodiment

Component	wt%, dry basis
glycerin	15.5
calcium carbonate	30
carboxymethylcellulose	10
milled tobacco	37
wood pulp (4% solution)	7.5

Example 4. Cast sheet base material embodiment-milled tobacco and wood pulp

Another example of a cast sheet base material embodiment of the disclosure was prepared according to the formula provided in Table 4, using the general procedure of Examples 1, 2, and 3, except that calcium carbonate was omitted from this formulation. The actual ingredients and percentages can be varied depending on the desired properties of the final product.

Table 4: Formulation of milled tobacco-wood pulp base material sheet embodiment

Component	wt%, dry basis
glycerin	15.5
carboxymethylcellulose	10
milled tobacco	67

Component	wt%, dry basis
wood pulp	7.5

Example 5. Cast sheet base material embodiment-wood pulp and maltodextrin

Another example of a cast sheet base material embodiment of the disclosure was prepared according to the formula provided in Table 5, using the general procedure of Examples 1-4, except that maltodextrin was substituted for tobacco. The actual ingredients and percentages can be varied depending on the desired properties of the final product.

Table 5: Formulation of wood pulp-maltodextrin base material sheet embodiment

Component	wt%, dry basis
glycerin	15.5
calcium carbonate	30
carboxymethylcellulose	10
wood pulp	7.5
maltodextrin	37

Example 6. Beaded material embodiment

An example of a beaded material embodiment of the disclosure was prepared according to the formula provided in Table 6. Milled tobacco and calcium carbonate were weighed and transferred into a model FM 130 D Littleford precision plough mixer. A premixed flavorant solution (including 2.3% flavorant, 50% glycerin, 45% water, and 2.3% carboxymethylcellulose) was added, and the contents mixed at 100 rpm for 10 minutes. After mixing, the Littleford contents were portioned and transferred into a single screw extruder (model MG55, Fuji Paudal). The mass was extruded through a 1.5 mm dome die, resulting in microfibril rod shaped strands. The rods were subsequently transferred into a model QJ-230T-2 Fuji Paudal Co. Ltd. laboratory marumerizer. The marumerizer rotating bowl was used to reshape the rods into rounded beads. Subsequently, the beads were transferred into a model Flo-Coater Vector Corporation fluidized bed agglomerator, and finally dried to 6% (±3%) moisture with 60-70°C heated air.

Table 6: Formulation of beads.

Component	wt%, dry basis
milled tobacco	29
calcium carbonate	29
flavor solution (55% w/v)	
water	19
flavorant	1
glycerin	21
carboxymethylcellulose	1

Example 7. Beaded material embodiment

Another example of a beaded material embodiment of the disclosure was prepared according to the formula provided in Table 7. Milled tobacco and calcium carbonate were weighed and transferred into a model FM 130 D Littleford precision plough mixer. Water and glycerin were added. The contents were mixed at 100

rpm for 10 min. The mixer was stopped, and a premade slurry of carboxymethylcellulose was added, and the contents mixed for another 20 minutes at 100 rpm. The premade slurry was prepared by hydrating carboxymethylcellulose with water in a vessel using a pitched fork propeller. This was carried out for 30 minutes. After mixing for 20 minutes, the Littleford contents were portioned and transferred into a single screw extruder. The mass was extruded through a 1.5 mm dome die, resulting in shaped rods. The rods were subsequently transferred into a model QJ-230T-2 Fuji Paudal Co. Ltd. laboratory marumerizer. The marumerizer rotating bowl was used to reshape the rods into rounded beads. Subsequently, the beads were transferred into a model Flo-Coater Vector Corporation fluidized bed agglomerator, and finally dried to 6% (±3%) moisture with 60-70°C heated air.

Table 7: Formulation of beads.

Component	wt%, wet
milled tobacco	30
calcium carbonate	29
water	25.3
glycerin	15
carboxymethylcellulose	0.7

Examples 8A-8C. Substrate embodiments with cast sheet base material and adhered beads

Three examples of substrate embodiments of the disclosure having a cast sheet base material and adhered beads were prepared by depositing the beads prepared according to Example 7 onto the wet cast sheet of each of Example 3, Example 4, and Example 5. The bead material was deposited onto the wet cast sheets using a doser. The beads comprised approximately 30% of the total substrate wet weight. The cast sheet with adhered beads was subsequently dried into a flat sheet by conveying the film through a 200-foot convection tunnel dryer, comprising multiple heated zones (e.g., ranging from 80-100°C). Photographs of the cast sheets with adhered beads are provided in FIG. 7 (cast sheet with no tobacco), FIG.8 (cast sheet with tobacco and calcium carbonate), and FIG. 9 (cast sheet with tobacco and no calcium carbonate), corresponding to each of Examples of 8A, 8B, and 8C, respectively.

CLAIMS

What is claimed is:

1. A composite substrate configured for use in an aerosol delivery device, the composite substrate comprising:

a first substrate material comprising a first filler, a binder, and an aerosol forming material; and

a second substrate material attached to the first substrate material, the second substrate material comprising a second filler, a second binder, and a second aerosol forming material.

2. The composite substrate of claim 1, wherein the second substrate material is in the form of one or more beads, sphere, or rods adhered to, or imbedded within, the first substrate material.

3. The composite substrate of claim 1 or 2, wherein the first substrate material is in the form of a sheet.

4. The composite substrate of claim 1 or 2, wherein the first substrate material is in the form of a shredded or particulate material.

5. The composite substrate of claim 1, wherein both the first substrate material and the second substrate material are in the form of sheets attached together in a layered configuration.

6. The composite substrate of any one of claims 1-5, wherein the first substrate material and the second substrate material have one or more of a different composition, a different density, and a different outer shape.

7. The composite substrate of claim 6, wherein the density of the second substrate material is at least about 10% higher than the density of the first substrate material

8. The composite substrate of any one of claims 1-7, wherein the first substrate material comprises at least about 50% by weight of the first filler, based on the total dry weight of the first substrate material.

9. The composite substrate of any one of claims 1-8, wherein the first substrate material comprises from about 50% to about 75% by weight of the first filler, based on the total dry weight of the first substrate material.

10. The composite substrate of any one of claims 1-9, wherein the first filler and the second filler are independently selected from the group consisting of a tobacco material, a botanical material, wood pulp, a

native or modified starch, maltodextrin, dextrose, calcium carbonate, a sugar alcohol, microcrystalline cellulose, and combinations thereof.

11. The composite substrate of any one of claims 1-10, wherein the first filler and the second filler are independently selected from the group consisting of a tobacco material, wood pulp, maltodextrin, calcium carbonate, and combinations thereof.

12. The composite substrate of any one of claims 1-10, wherein the first filler and the second filler are independently selected from the group consisting of wood pulp, maltodextrin, calcium carbonate, and combinations thereof.

13. The composite substrate of any one of claims 1-12, wherein the first binder and second binder comprise a cellulose ether independently selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof.

14. The composite substrate of any one of claims 1-13, wherein the first binder and the second binder comprise CMC.

15. The composite substrate of any one of claims 1-15, wherein the first aerosol forming material and the second aerosol forming material are independently selected from the group consisting of water, a polyhydric alcohol, a polysorbate, a sorbitan ester, a fatty acid, a fatty acid ester, a wax, a cannabinoid, a terpene, a sugar alcohol, and combinations thereof.

16. The composite substrate of any one of claims 1-15, wherein the first aerosol forming material and the second aerosol forming material each comprise a polyhydric alcohol.

17. The composite substrate of claim 16, wherein the polyhydric alcohol is selected from the group consisting of glycerin, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof.

18. The composite substrate of any one of claims 1-17, wherein the first substrate material comprises:

a tobacco material in an amount from about 0 to about 70% by weight, based on the total wet weight of the first substrate material;

wood pulp in an amount from about 0 to about 10% by weight, based on the total wet weight of the first substrate material;

calcium carbonate in an amount from about 0 to about 30% by weight, based on the total wet weight of the first substrate material;

maltodextrin in an amount from about 0 to about 40% by weight, based on the total wet weight of the first substrate material;

glycerin in an amount from about 10 to about 20% by weight, based on the total wet weight of the first substrate material;

carboxymethylcellulose in an amount from about 5 to about 15% by weight, based on the total wet weight of the first substrate material; and

water in an amount up to about 30% by weight, based on the total wet weight of the first substrate material.

19. The composite substrate of any one of claims 1-18, wherein the first substrate material further comprises a flavorant, an active ingredient, a tobacco extract, or a combination thereof.

20. The composite substrate of claim 19, wherein the active ingredient comprises a nicotine component.

21. The composite substrate of claim 2, wherein the beads, sphere, or rods comprise at least about 50% by weight of the second filler, based on the total dry weight of the beads.

22. The composite substrate of claim 2, wherein the beads, sphere, or rods comprise from about 50% to about 65% by weight of the second filler, based on the total dry weight of the beads.

23. The composite substrate of claim 2, wherein the second filler comprises a tobacco material, a botanical material, calcium carbonate, or a combination thereof.

24. The composite substrate of claim 2, wherein the second filler is selected from the group consisting of a tobacco material, calcium carbonate, and combinations thereof.

25. The composite substrate of claim 2, wherein the second binder is selected from the group consisting of methylcellulose, hydroxypropyl cellulose (HPC), hydroxypropyl methylcellulose (HPMC), hydroxyethyl cellulose, carboxymethylcellulose (CMC), and combinations thereof.

26. The composite substrate of claim 25, wherein the second binder is CMC.

27. The composite substrate of claim 2, wherein the beads, spheres or rods comprise:

a tobacco material in an amount from about 20 to about 40% by weight, based on the total dry weight of the beads, spheres or rods;

calcium carbonate in an amount from about 20 to about 40% by weight, based on the total dry weight of the beads, spheres or rods;

glycerin in an amount from about 0 to about 20% by weight, based on the total dry weight of the beads, spheres or rods; and

carboxymethylcellulose in an amount from about 0 to about 2% by weight, based on the total dry weight of the beads, spheres or rods.

28. The composite substrate of claim 2, wherein the beads, spheres or rods further comprise a flavorant, an active ingredient, or a combination thereof.

29. The composite substrate of claim 2, wherein the second aerosol forming material is selected from the group consisting of water, a polyhydric alcohol, a polysorbate, a sorbitan ester, a fatty acid, a fatty acid ester, a wax, a cannabinoid, a terpene, a sugar alcohol, and combinations of any thereof.

30. The composite substrate of claim 29, wherein the polyhydric alcohol is selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, triacetin, and combinations thereof.

31. The composite substrate of claim 2, comprising from about 10 to about 50% by weight of the beads, spheres or rods, based on the total weight of the composite substrate.

32. The composite substrate of claim 2, wherein the beads, spheres, or rods have a diameter in a range from about 0.1 mm to about 5 mm.

33. The composite substrate of claim 2, wherein the beads, spheres or rods are adhered to the surface of the first substrate material in a randomly spaced pattern.

34. The composite substrate of claim 2, wherein the beads, spheres or rods are adhered to the surface of the first substrate material in a uniformly spaced pattern.

35. The composite substrate of any one of claims 1-34, wherein the substrate is substantially free of wood fibers.

36. The composite substrate of any one of claims 1-35, wherein the substrate is substantially free of tobacco material.

37. The composite substrate of any one of claims 1-36, in the form of a flat sheet, a gathered sheet, multiple layered sheets, a rolled sheet, or in shredded form.

38. The composite substrate of any one of claims 1-36 in shredded form, further comprising a tobacco material blended therewith.

39. An aerosol delivery device, comprising:

the composite substrate of any one of claims 1-38;

a heat source configured to heat the composite substrate to form an aerosol; and

an aerosol pathway extending from the composite substrate to a mouth-end of the aerosol delivery device.

40. The aerosol delivery device of claim 39, wherein the heat source comprises either an electrically powered heating element or a combustible ignition source.

41. The aerosol delivery device of claim 40, wherein the heat source is a combustible ignition source comprising a carbon-based material.

42. The aerosol delivery device of claim 40, wherein the heat source is an electrically powered heating element.

43. The aerosol delivery device of claim 42, further comprising a power source electronically connected to the heating element.

44. The aerosol delivery device of claim 43, further comprising a controller configured to control the power transmitted by the power source to the heating element.

45. A method of making a composite substrate configured for use in an aerosol delivery device, the method comprising:

(a) preparing a slurry comprising a first filler, a first binder, and a first aerosol forming material;

(b) casting the slurry onto a supportive device to form a first substrate material in the form of a wet sheet;

(c) preparing a second substrate material comprising a second filler, a second binder, and a second aerosol forming material, wherein the second substrate material is in beaded form;
(d) depositing the second substrate material onto a surface of the first substrate material; and
(e) drying the first substrate material having deposited thereon the second substrate material in beaded form, to form the composite substrate, wherein the second substrate material in beaded form is adhered to a surface of the first substrate material substrate.

46. The method of claim 45, wherein the slurry comprises:

a tobacco or botanical material in an amount from about 0 to about 70% by weight, based on the total wet weight of the slurry;

wood pulp in an amount from about 0 to about 10% by weight, based on the total wet weight of the slurry;

an additional first filler in an amount from about 0 to about 70% by weight, based on the total wet weight of the slurry, the additional first filler comprising a native or modified starch, maltodextrin, dextrose, calcium carbonate, a sugar alcohol, microcrystalline cellulose, or a combination thereof;

the first aerosol forming material in an amount from about 10 to about 20% by weight, based on the total wet weight of the slurry;

a cellulose ether in an amount from about 5 to about 15% by weight, based on the total wet weight of the slurry; and

water in an amount up to about 30% by weight, based on the total wet weight of the slurry.

47. The method of claim 46, wherein the second substrate material in beaded form comprises:

a tobacco or botanical material in an amount from about 20 to about 40% by weight, based on the total dry weight of the second substrate material;

an additional second filler in an amount from about 20 to about 40% by weight, based on the total dry weight of the second substrate material;

the second aerosol former in an amount from about 0 to about 20% by weight, based on the total dry weight of the second substrate material; and

a cellulose ether in an amount from about 0 to about 2% by weight, based on the total dry weight of the second substrate material.

48. The method of claim 46, further comprising:

(f) casting a layer of the slurry onto the composite substrate of (e), forming a wet layered composite substrate; and

(g) drying the wet layered composite substrate, forming a layered composite substrate with the second substrate material in beaded form embedded therein.

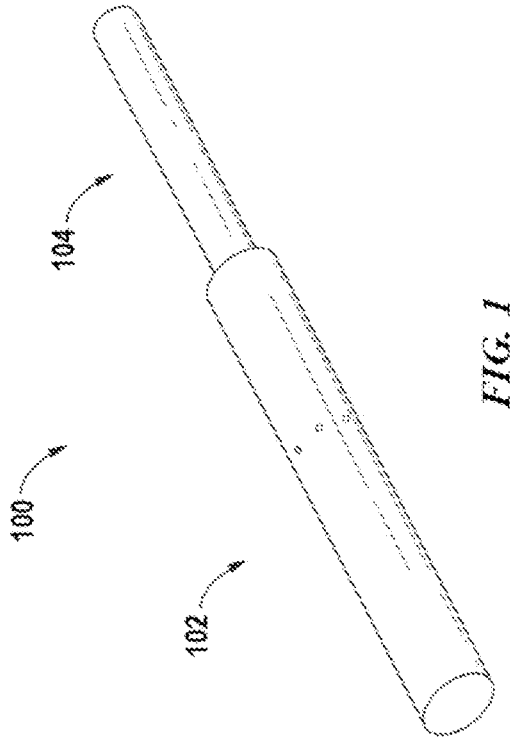

FIG. 1

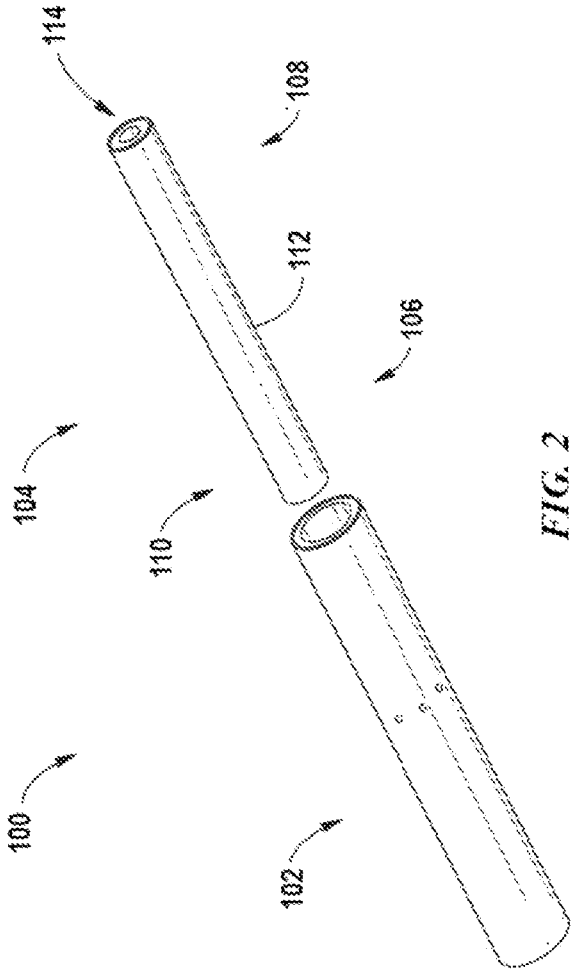

FIG. 2

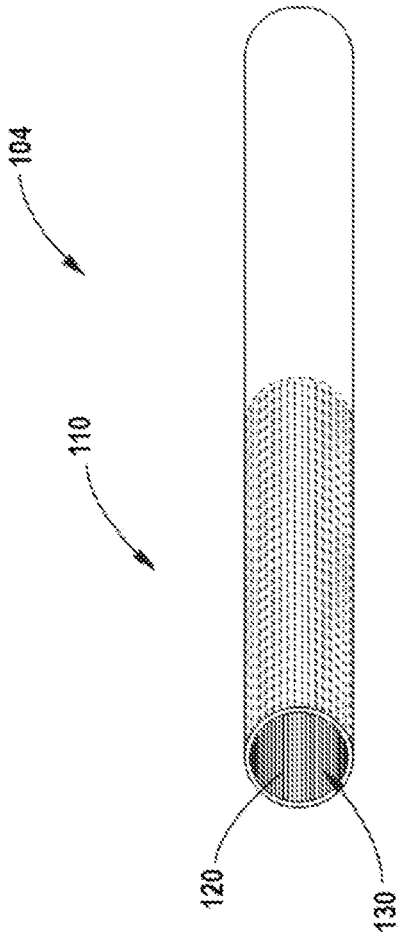

FIG. 3

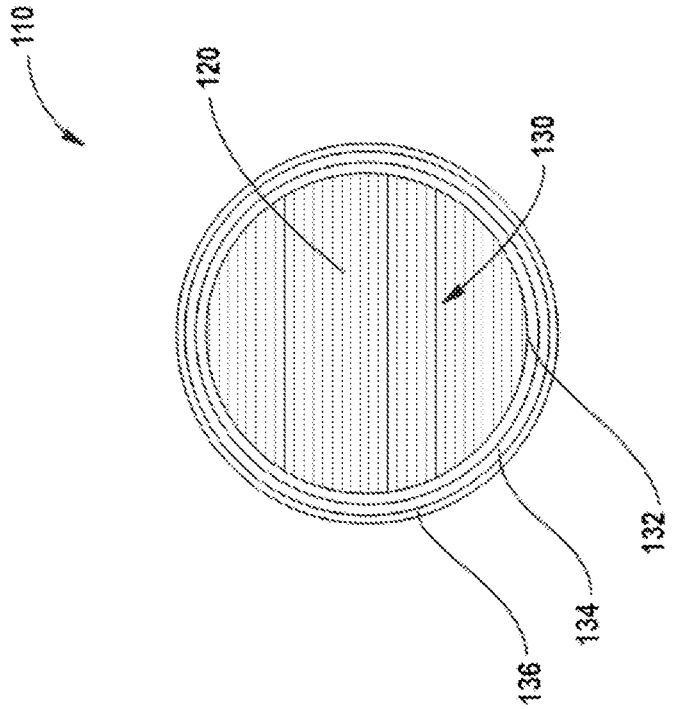

FIG. 4

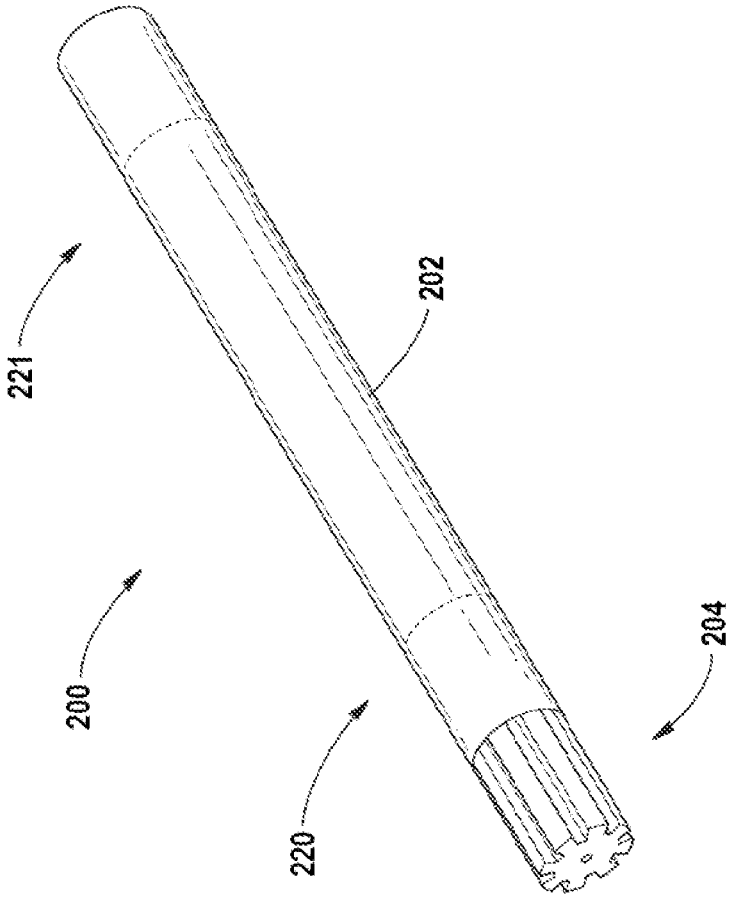

FIG. 5

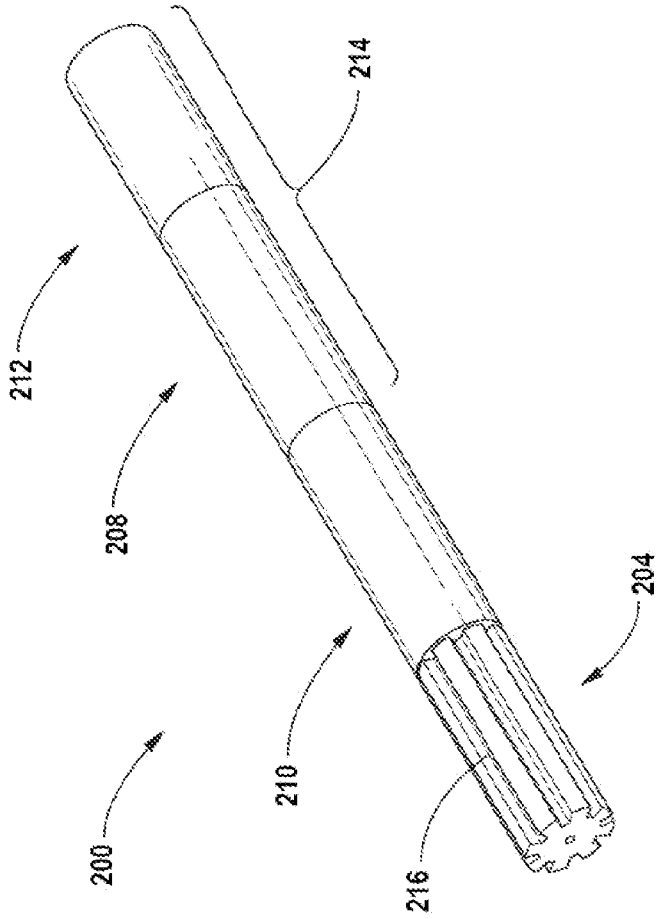

FIG. 6

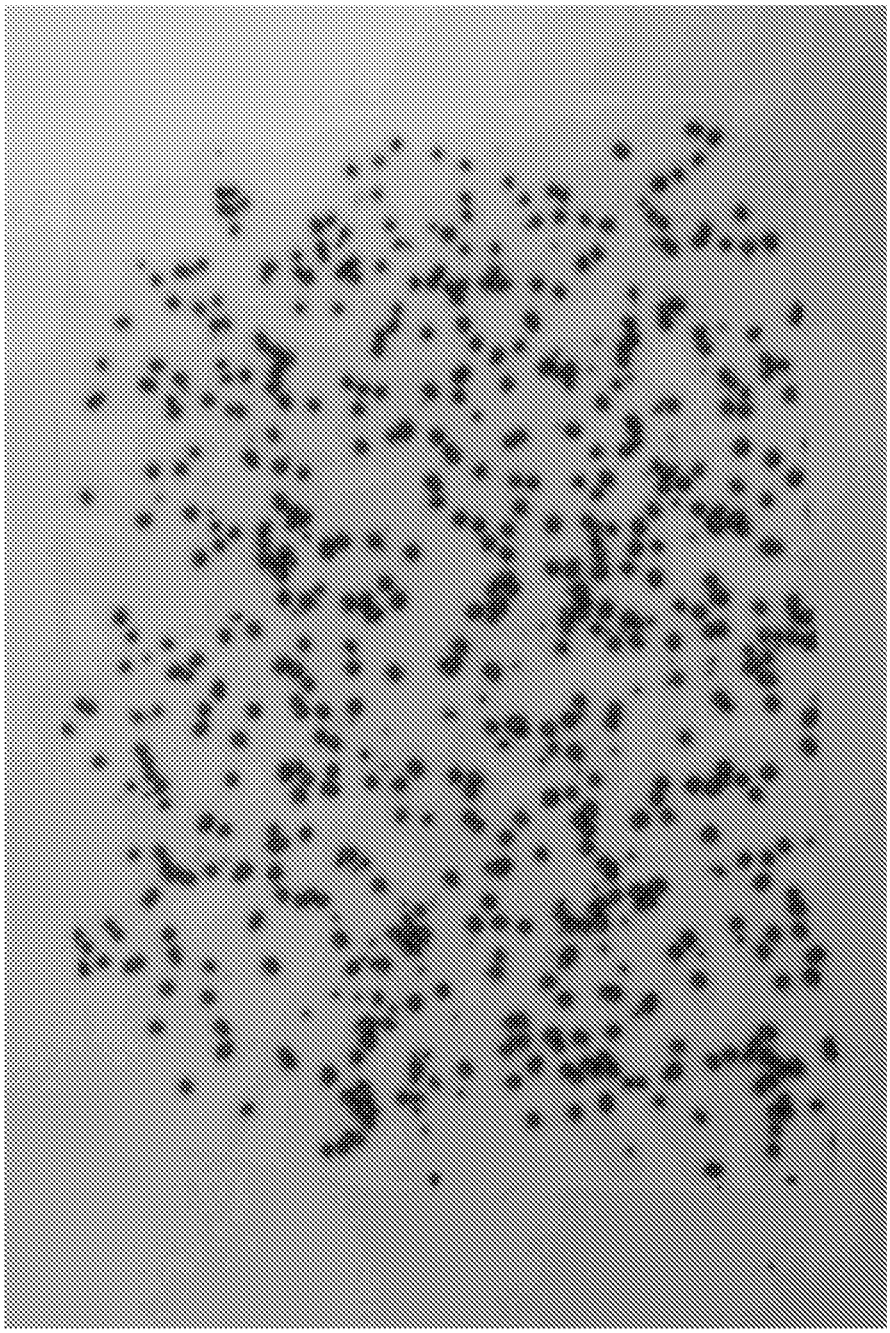

FIG. 7

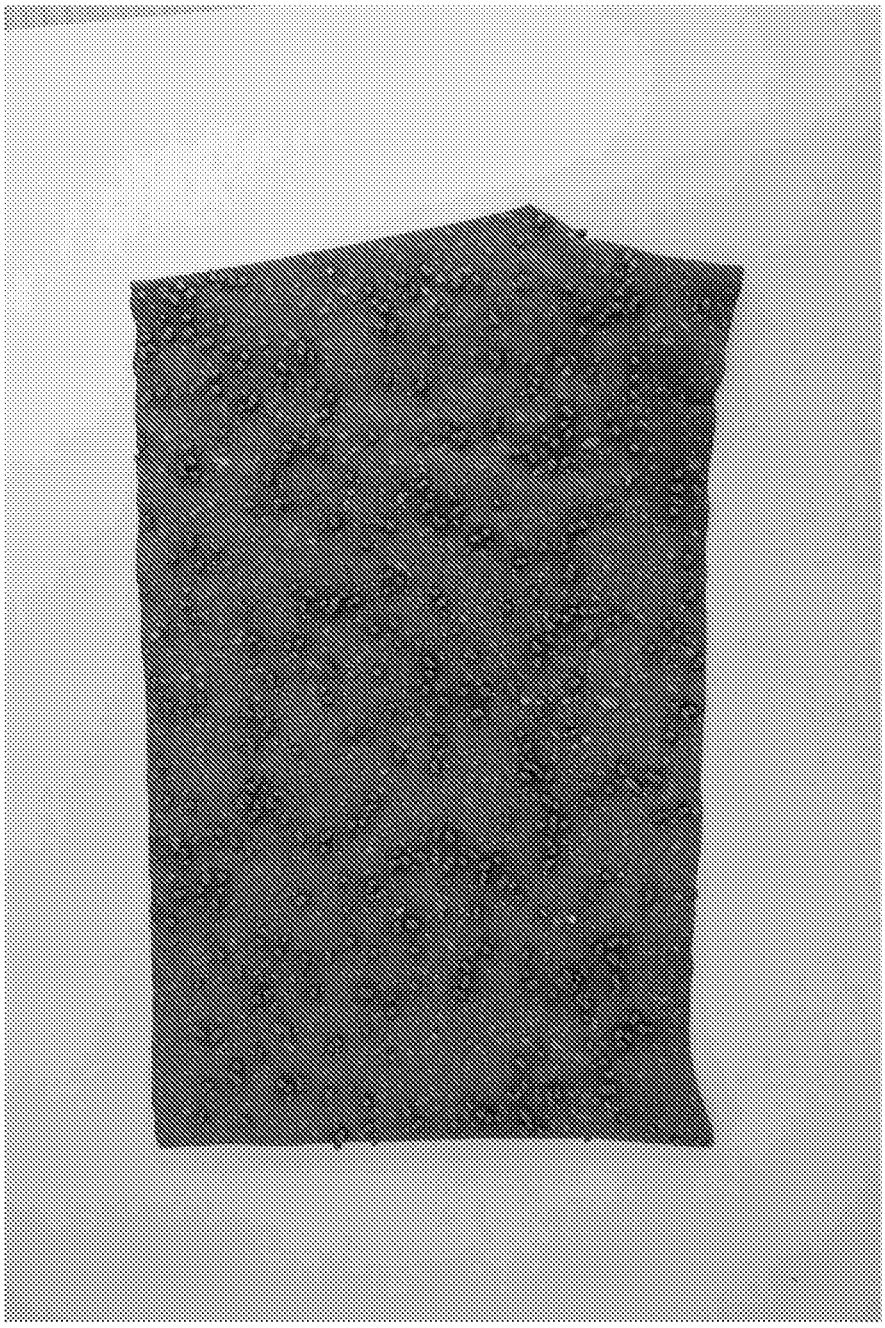

FIG. 8

FIG. 9