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(54) Title: SUBSTRATE WITH MULTIPLE AEROSOL FORMING MATERIALS FOR AEROSOL DELIVERY DEVICE

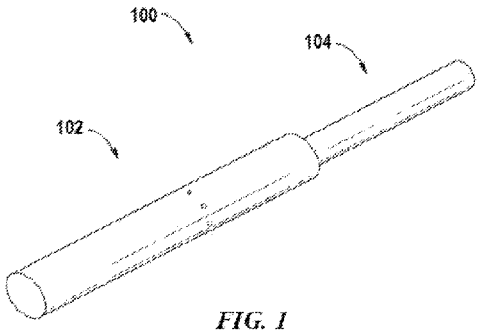


FIG. 1

(57) Abstract: The present disclosure provides an aerosol generating component including a substrate impregnated with two or more aerosol forming materials, including a first aerosol forming material and a second aerosol forming material, wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both. The disclosed aerosol generating component may be utilized in aerosol delivery devices such as heat not burn (HNB) or electrically heated aerosol delivery devices.

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SUBSTRATE WITH MULTIPLE AEROSOL FORMING MATERIALS FOR AEROSOL DELIVERY DEVICE

FIELD OF THE DISCLOSURE

The present disclosure relates to aerosol generating components, aerosol delivery devices, and aerosol delivery systems, such as smoking articles, that utilize electrically-generated heat or combustible ignition sources to heat aerosol forming materials, preferably 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 or plant-derived materials have suffered from inconsistent performance characteristics. For example, some articles have suffered from inconsistent release of flavors or other inhalable materials and inadequate loading of aerosol forming materials on substrates. Accordingly, it can be desirable to provide a smoking article that can provide the sensations of cigarette, cigar, or pipe smoking, that does so without combusting the substrate material and that does so with advantageous performance characteristics.

Aerosol delivery devices wherein a solid fuel, such as carbon, is combusted to transfer heat to tobacco, as well as aerosol delivery devices utilizing electrically generated heat, have aerosol forming substrates as part of the aerosol generating component. Typically, only one aerosol former is used in the aerosol forming substrate. Hence, the propensity for aerosol formation when the substrate is heated will depend on the boiling temperature or vapor pressure of the aerosol former. In both types of devices, it

would be advantageous to provide a substrate comprising multiple aerosol formers to allow for controlled release of aerosol over time as the substrate is heated.

BRIEF SUMMARY

The present disclosure relates to aerosol generating components and aerosol delivery devices that utilize electrically-generated heat or combustible ignition sources to heat a substrate impregnated with two or more aerosol forming materials, in order to provide an inhalable substance in the form of an aerosol for human consumption.

Accordingly, in one aspect, the disclosure provides an aerosol generating component comprising a substrate impregnated with two or more aerosol forming materials, including a first aerosol forming material and a second aerosol forming material, wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both.

In some embodiments, the first aerosol forming material and the second aerosol forming material are independently selected from the group consisting of water, polyhydric alcohols, polysorbates, sorbitan esters, fatty acids, fatty acid esters, waxes, triacetin, and sugar alcohols. In some embodiments, at least one of the first aerosol forming material and the second aerosol forming material is a polyhydric alcohol. In some embodiments, the two or more aerosol forming materials are present in a ratio by weight of the first aerosol forming material to the second aerosol forming material of from about 3:1 to about 1:3.

In some embodiments, the first aerosol forming material and the second aerosol forming material are both polyhydric alcohols. In some embodiments, the polyhydric alcohols are selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, and combinations thereof. In some embodiments, the polyhydric alcohols are glycerol and propylene glycol. 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 1:1.

In some embodiments, the substrate is further impregnated with at least one additional aerosol former. In some embodiments, the at least one additional aerosol former is selected from the group consisting of water, polysorbates, sorbitan esters, fatty acids, fatty acid esters, waxes, triacetin, sugar alcohols, cannabinoids, terpenes, and combinations thereof.

In some embodiments, the substrate is further impregnated with a flavorant, an active ingredient, or a combination thereof. In some embodiments, the active ingredient comprises a tobacco component, a non-tobacco botanical, a nicotine component, or a combination thereof. In some embodiments, the active ingredient comprises a nicotine component.

In some embodiments, the substrate is in particulate form, shredded form, film form, paper process sheet form, cast sheet form, bead form, granular rod form, or extrudate form.

In some embodiments, the substrate is formed into a substantially cylindrical shape.

In some embodiments, the substrate comprises tobacco-derived fibers, wood-derived fibers, or a combination thereof.

In some embodiments, the substrate further comprises one or more binders. In some embodiments, the one or more binders are selected from alginates, cellulose derivatives, starches, gums, dextrans, carrageenan, calcium carbonate, or combinations thereof. In some embodiments, the substrate comprises one or more of calcium carbonate, an alginate, one or more cellulose derivatives, a starch, wood pulp, or tobacco-derived fibers.

In some embodiments, the two or more aerosol forming materials are present in a ratio by weight of from about 3:1 to about 1:3. In some embodiments, the two or more aerosol forming materials are glycerol and propylene glycol.

In some embodiments, the substrate comprises from about 0 to about 60% by weight of calcium carbonate; from about 0 to about 10% by weight of an alginate; from about 0 to about 5% by weight of one or more cellulose derivatives; from about 0 to about 30% by weight of a starch; from about 0 to about 5% by weight of wood pulp; from about 0 to about 80% by weight of tobacco-derived fibers; and the substrate is impregnated with the two or more aerosol forming materials at a loading of from about 15 to about 55% by weight, based on a total weight of the impregnated substrate.

In some embodiments, the substrate comprises from about 0 to about 5% by weight of calcium carbonate; from about 1% to about 5% by weight of wood pulp; from about 70 to about 80% by weight of tobacco-derived fibers; and the substrate is impregnated with the two or more aerosol forming materials at a loading of about 15 to about 25% by weight, based on a total weight of the impregnated substrate.

In some embodiments, the substrate comprises from about 45 to about 60% by weight of calcium carbonate; from about 0 to about 10% by weight of an alginate; from about 0 to about 5% by weight of one or more cellulose derivatives; from about 0 to about 15% by weight of a starch; from about 0 to about 5% by weight of wood pulp; from about 0 to about 40% by weight of tobacco-derived fibers; and the substrate is impregnated with the two or more aerosol forming materials at a loading of from about 15 to about 25% by weight, based on a total weight of the impregnated substrate.

In some embodiments, the substrate comprises from about 40 to about 60% by weight of calcium carbonate; from about 0 to about 10% by weight of an alginate; from about 0 to about 5% by weight of one or more cellulose derivatives; from about 0 to about 15% by weight of a starch; from about 0 to about 5% by weight of wood pulp; from about 0 to about 40% by weight of tobacco-derived fibers; and the substrate is impregnated with the two or more aerosol forming materials at a loading of from about 15 to about 25% by weight, based on a total weight of the impregnated substrate.

In some embodiments, the substrate comprises from about 5 to about 15% by weight of calcium carbonate; from about 1 to about 5% by weight of one or more cellulose derivatives; from about 20 to about 40% by weight of a starch; from about 20 to about 40% by weight of tobacco-derived fibers; and wherein the substrate is impregnated with the two or more aerosol forming materials at a loading of from about 15 to about 25% by weight, based on a total weight of the impregnated substrate.

In another aspect is provided an aerosol generating component comprising a substrate impregnated with two or more aerosol forming materials, including: a first aerosol forming material selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, a polyethylene glycol, triacetin, and combinations thereof; and a second aerosol forming material selected from the group consisting of polysorbates, sorbitan esters, fatty acids, fatty acid esters, 1,3-propanediol, triethylene glycol, a polyethylene glycol, triacetin, waxes, cannabinoids, terpenes, and sugar alcohols; wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both; and wherein the substrate is impregnated with the two or more aerosol forming materials at a loading from about 5 to about 60% by weight, based on the total weight of the impregnated substrate.

In some embodiments, substrate is impregnated with the two or more aerosol forming materials at a loading from about 15 to about 30% by weight, based on a total weight of the impregnated substrate.

In some embodiments, a ratio by weight of the first aerosol forming material to the second aerosol forming material is from about 100:1 to about 1:100. In some embodiments, a ratio by weight of the first aerosol forming material to the second aerosol forming material is from about 3:1 to about 1:3.

In some embodiments, the second aerosol forming material is selected from the group consisting of palmitic acid, polyethylene glycol 400, sorbitan tristearate, polysorbate 80, and combinations thereof.

In some embodiments, the first aerosol forming material is glycerol, and the second aerosol forming material is 1,3-propanediol, triethylene glycol, palmitic acid, or triacetin. In some embodiments, the first aerosol forming material is glycerol, and the second aerosol forming material is palmitic acid.

In some embodiments, the first aerosol forming material is 1,3-propanediol, triethylene glycol, propylene glycol, or triacetin; and the second aerosol forming material is palmitic acid, polyethylene glycol 400, sorbitan tristearate, or polysorbate 80.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and a third aerosol forming material selected from the group consisting of 1,3-propanediol, triethylene glycol, propylene glycol, triacetin, polyethylene glycol 400, sorbitan tristearate, and polysorbate 80.

In some embodiments, the substrate is impregnated with a mixture selected from the group consisting of: glycerol and palmitic acid; glycerol and 1,3-propanediol; glycerol and triethylene glycol; glycerol and triacetin; 1,3-propanediol and palmitic acid; 1,3-propanediol and polyethylene glycol; 1,3-propanediol and polysorbate 80; triethylene glycol and palmitic acid; triethylene glycol and polyethylene glycol; triethylene glycol and polysorbate 80; triacetin and palmitic acid; triacetin and polyethylene glycol; triacetin and polysorbate 80; propylene glycol and palmitic acid; propylene glycol and polyethylene glycol; and propylene glycol and polysorbate 80. In some embodiments, in each listed mixture, a ratio of the aerosol forming materials is from about 3:1 to about 1:3.

In some embodiments, the substrate is impregnated with a mixture comprising glycerol, palmitic acid, and propylene glycol.

In some embodiments, the aerosol generating component further comprises triacetin.

In some embodiments, the substrate further comprises water in an amount by weight of up to about 10%, based on the total dry weight of the impregnated substrate.

In some embodiments, the substrate comprises tobacco-derived fibers, wood-derived fibers, plant or plant-derived fibers, synthetic fibers, or a combination thereof, and one or more binders. In some embodiments, the one or more binders are selected from alginates, cellulose derivatives, starches, gums, dextrans, carrageenan, calcium carbonate, or combinations thereof.

In some embodiments, the substrate comprises: from about 40 to about 70% by weight of tobacco-derived fibers; from about 10 to about 15% by weight of a cellulose derivative; and from about 5 to about 10% by weight of wood pulp.

In some embodiments, the substrate is further impregnated with a flavorant, an active ingredient, or a combination thereof. In some embodiments, the active ingredient comprises a tobacco component, a non-tobacco botanical, a nicotine component, or a combination thereof. In some embodiments, the active ingredient comprises a nicotine component.

In some embodiments, the substrate is in particulate form, shredded form, film form, paper process sheet form, cast sheet form, bead form, granular form, rod form, or extrudate form. In some embodiments, the substrate is formed into a substantially cylindrical shape.

In another aspect is provided an aerosol delivery device, comprising the aerosol generating component as disclosed herein; a heat source configured to heat the aerosol forming materials impregnated 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.

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: An aerosol generating component comprising a substrate impregnated with two or more aerosol forming materials, including a first aerosol forming material and a second aerosol forming material, wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both.

Embodiment 2: The aerosol generating component of the first embodiment, wherein the first aerosol forming material and the second aerosol forming material are independently selected from the group consisting of water, polyhydric alcohols, polysorbates, sorbitan esters, fatty acids, fatty acid esters, waxes, triacetin, and sugar alcohols.

Embodiment 3: The aerosol generating component of the first or second embodiment, wherein the two or more aerosol forming materials are present in a ratio by weight of the first aerosol forming material to the second aerosol forming material of from about 3:1 to about 1:3.

Embodiment 4: The aerosol generating component of any one of embodiments 1 to 3, wherein at least one of the first aerosol forming material and the second aerosol forming material is a polyhydric alcohol.

Embodiment 5: The aerosol generating component of any one of embodiments 1 to 4, wherein the first aerosol forming material and the second aerosol forming material are both polyhydric alcohols.

Embodiment 6: The aerosol generating component of any one of embodiments 1 to 5, wherein the polyhydric alcohols are selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, and combinations thereof.

Embodiment 7: The aerosol generating component of any one of embodiments 1 to 6, wherein the polyhydric alcohols are glycerol and propylene glycol.

Embodiment 8: The aerosol generating component of any one of embodiments 1 to 7, wherein the glycerol and propylene glycol are present in a ratio by weight of from about 3:1 to about 1:3.

Embodiment 9: The aerosol generating component of any one of embodiments 1 to 8, wherein the glycerol and propylene glycol are present in a ratio by weight of about 1:1.

Embodiment 10: The aerosol generating component of any one of embodiments 1 to 9, wherein the substrate is further impregnated with at least one additional aerosol former.

Embodiment 11: The aerosol generating component of any one of embodiments 1 to 10, wherein the at least one additional aerosol former is selected from the group consisting of water, polysorbates, sorbitan esters, fatty acids, fatty acid esters, waxes, triacetin, sugar alcohols, cannabinoids, terpenes, and combinations thereof.

Embodiment 12: The aerosol generating component of any one of embodiments 1 to 11, wherein the substrate is further impregnated with a flavorant, an active ingredient, or a combination thereof.

Embodiment 13: The aerosol generating component of any one of embodiments 1 to 12, wherein the active ingredient comprises a non-tobacco botanical, a tobacco component, a nicotine component, or a combination thereof.

Embodiment 14: The aerosol generating component of any one of embodiments 1 to 13, wherein the active ingredient comprises a nicotine component.

Embodiment 15: The aerosol generating component of any one of embodiments 1 to 14, wherein the substrate is impregnated with the two or more aerosol forming materials at a loading of from about 15 to about 55% by weight, based on a total weight of the impregnated substrate.

Embodiment 16: The aerosol generating component of any one of embodiments 1 to 15, wherein the substrate is in particulate form, shredded form, film form, paper process sheet form, cast sheet form, bead form, granular rod form, or extrudate form.

Embodiment 17: The aerosol generating component of any one of embodiments 1 to 16, wherein the substrate is formed into a substantially cylindrical shape.

Embodiment 18: The aerosol generating component of any one of embodiments 1 to 17, wherein the substrate comprises tobacco-derived fibers, wood-derived fibers, or a combination thereof.

Embodiment 19: The aerosol generating component of any one of embodiments 1 to 18, wherein the substrate further comprises one or more binders.

Embodiment 20: The aerosol generating component of any one of embodiments 1 to 19, wherein the one or more binders are selected from alginates, cellulose derivatives, starches, gums, dextrans, carrageenan, calcium carbonate, or combinations thereof.

Embodiment 21: The aerosol generating component of any one of embodiments 1 to 20, wherein the substrate comprises one or more of calcium carbonate, an alginate, one or more cellulose derivatives, a starch, wood pulp, or tobacco-derived fibers.

Embodiment 22: The aerosol generating component of any one of embodiments 1 to 21, wherein the two or more aerosol forming materials are present in a ratio by weight of the first aerosol forming material to the second aerosol forming material of from about 3:1 to about 1:3.

Embodiment 23: The aerosol generating component of any one of embodiments 1 to 22, wherein the two or more aerosol forming materials are glycerol and propylene glycol.

Embodiment 24: The aerosol generating component of any one of embodiments 1 to 23, wherein the substrate comprises from about 0 to about 5% by weight of calcium carbonate; from about 1% to about 5% by weight of wood pulp; from about 70 to about 80% by weight of tobacco-derived fibers; and wherein the substrate is impregnated with the two or more aerosol forming materials at a loading of about 15 to about 25% by weight, based on a total weight of the impregnated substrate.

Embodiment 25: The aerosol generating component of any one of embodiments 1 to 24, wherein the substrate comprises from about 45 to about 60% by weight of calcium carbonate; from about 0 to about 10% by weight of an alginate; from about 0 to about 5% by weight of one or more cellulose derivatives; from about 0 to about 15% by weight of a starch; from about 0 to about 5% by weight of wood pulp; from about 0 to about 40% by weight of tobacco-derived fibers; and wherein the substrate is impregnated with the two or more aerosol forming materials at a loading of from about 15 to about 25% by weight, based on a total weight of the impregnated substrate.

Embodiment 26: The aerosol generating component of any one of embodiments 1 to 25, wherein the substrate comprises from about 40 to about 60% by weight of calcium carbonate; from about 0 to about 10% by weight of an alginate; from about 0 to about 5% by weight of one or more cellulose derivatives; from about 0 to about 15% by weight of a starch; from about 0 to about 5% by weight of wood pulp; from about 0 to about 40% by weight of tobacco-derived fibers; and wherein the substrate is impregnated with the two or more aerosol forming materials at a loading of from about 15 to about 25% by weight, based on a total weight of the impregnated substrate.

Embodiment 27: The aerosol generating component of any one of embodiments 1 to 26, wherein the substrate comprises from about 5 to about 15% by weight of calcium carbonate; from about 1 to about 5% by weight of one or more cellulose derivatives; from about 20 to about 40% by weight of a starch; from about 20 to about 40% by weight of tobacco-derived fibers; and wherein the substrate is impregnated with the two or more aerosol forming materials at a loading of from about 15 to about 25% by weight, based on a total weight of the impregnated substrate.

Embodiment 28: An aerosol generating component comprising a substrate impregnated with two or more aerosol forming materials, including: a first aerosol forming material selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, a polyethylene glycol, triacetin, and combinations thereof; and a second aerosol forming material different from the first aerosol forming material and selected from the group consisting of polysorbates, sorbitan esters, fatty acids, fatty acid esters, 1,3-propanediol, triethylene glycol, a polyethylene glycol, triacetin, waxes, cannabinoids, terpenes, and sugar alcohols; wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both; and wherein the substrate is impregnated with the two or more aerosol forming materials at a loading from about 5 to about 60% by weight, based on the total weight of the impregnated substrate.

Embodiment 29: The aerosol generating component of embodiment 28, wherein the substrate is impregnated with the two or more aerosol forming materials at a loading from about 15 to about 30% by weight, based on a total weight of the impregnated substrate.

Embodiment 30: The aerosol generating component of embodiment 28 or 29, wherein a ratio by weight of the first aerosol forming material to the second aerosol forming material is from about 100:1 to about 1:100.

Embodiment 31: The aerosol generating component of any one of embodiments 28-30, wherein a ratio by weight of the first aerosol forming material to the second aerosol forming material is from about 3:1 to about 1:3.

Embodiment 32: The aerosol generating component of any one of embodiments 28-31, wherein the second aerosol forming material is selected from the group consisting of palmitic acid, polyethylene glycol 400, sorbitan tristearate, polysorbate 80, and combinations thereof.

Embodiment 33: The aerosol generating component of any one of embodiments 28-31, wherein the first aerosol forming material is glycerol, and the second aerosol forming material is 1,3-propanediol, triethylene glycol, palmitic acid, or triacetin.

Embodiment 34: The aerosol generating component of any one of embodiments 28-31, wherein the first aerosol forming material is glycerol, and the second aerosol forming material is palmitic acid.

Embodiment 35: The aerosol generating component of any one of embodiments 28-31, wherein: the first aerosol forming material is 1,3-propanediol, triethylene glycol, propylene glycol, or triacetin; and the second aerosol forming material is palmitic acid, polyethylene glycol 400, sorbitan tristearate, or polysorbate 80.

Embodiment 36: The aerosol generating component of any one of embodiments 28-31, wherein the substrate is impregnated with glycerol, palmitic acid, and a third aerosol forming material selected from the group consisting of 1,3-propanediol, triethylene glycol, propylene glycol, triacetin, polyethylene glycol 400, sorbitan tristearate, and polysorbate 80.

Embodiment 37: The aerosol generating component of any one of embodiments 28-31, wherein the substrate is impregnated with a mixture selected from the group consisting of glycerol and palmitic acid; glycerol and 1,3-propanediol; glycerol and triethylene glycol; glycerol and triacetin; 1,3-propanediol and palmitic acid; 1,3-propanediol and polyethylene glycol; 1,3-propanediol and polysorbate 80; triethylene glycol and palmitic acid; triethylene glycol and polyethylene glycol; triethylene glycol and polysorbate 80; triacetin and palmitic acid; triacetin and polyethylene glycol; triacetin and polysorbate 80; propylene glycol and palmitic acid; propylene glycol and polyethylene glycol; and propylene glycol and polysorbate 80.

Embodiment 38: The aerosol generating component of embodiment 37, wherein in each listed mixture, a ratio of the aerosol forming materials is from about 3:1 to about 1:3.

Embodiment 39: The aerosol generating component of any one of embodiments 28-31, wherein the substrate is impregnated with a mixture comprising glycerol, palmitic acid, and propylene glycol.

Embodiment 40: The aerosol generating component of embodiment 39, further comprising triacetin.

Embodiment 41: The aerosol generating component of any one of embodiments 28-40, wherein the substrate further comprises water in an amount by weight of up to about 10%, based on the total dry weight of the impregnated substrate.

Embodiment 42: The aerosol generating component of any one of embodiments 28-41, wherein the substrate comprises tobacco-derived fibers, wood-derived fibers, plant or plant-derived fibers, synthetic fibers, or a combination thereof, and one or more binders.

Embodiment 43: The aerosol generating component of embodiment 42, wherein the one or more binders are selected from alginates, cellulose derivatives, starches, gums, dextrans, carrageenan, calcium carbonate, or combinations thereof.

Embodiment 44: The aerosol generating component of any one of embodiments 28-43, wherein the substrate comprises: from about 40 to about 70% by weight of tobacco-derived fibers; from about 10 to about 15% by weight of a cellulose derivative; and from about 5 to about 10% by weight of wood pulp.

Embodiment 45: The aerosol generating component of any one of embodiments 28-44, wherein the substrate is further impregnated with a flavorant, an active ingredient, or a combination thereof.

Embodiment 46: The aerosol generating component of embodiment 45, wherein the active ingredient comprises a tobacco component, a non-tobacco botanical, a nicotine component, or a combination thereof.

Embodiment 47: The aerosol generating component of embodiment 45, wherein the active ingredient comprises a nicotine component.

Embodiment 48: The aerosol generating component of any one of embodiments 28-47, wherein the substrate is in particulate form, shredded form, film form, paper process sheet form, cast sheet form, bead form, granular form, rod form, or extrudate form.

Embodiment 49: The aerosol generating component of any one of embodiments 28-48, wherein the substrate is formed into a substantially cylindrical shape.

Embodiment 50: An aerosol delivery device, comprising the aerosol generating component of any one of embodiments 1 to 49; a heat source configured to heat the impregnated substrate to form an aerosol; and an aerosol pathway extending from the aerosol generating component to a mouth-end of the aerosol delivery device.

Embodiment 51: The aerosol delivery device of embodiment 50, wherein the heat source comprises either an electrically powered heating element or a combustible ignition source.

Embodiment 52: The aerosol delivery device of embodiment 50 or 51, wherein the heat source is a combustible ignition source comprising a carbon-based material.

Embodiment 53: The aerosol delivery device of embodiment 50 or 51, wherein the heat source is an electrically-powered heating element.

Embodiment 54: The aerosol delivery device of embodiment 53, further comprising a power source electronically connected to the heating element.

Embodiment 55: The aerosol delivery device embodiment 54, further comprising a controller configured to control the power transmitted by the power source to the heating element.

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 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 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 bar graph depicting the thermal energy required to evaporate glycerol, propylene glycol, and mixtures thereof as measured by Differential Scanning Calorimetry (DSC);

FIG. 8 is a graphical depiction overlaying ion current curves for glycerol for paper-process reconstituted samples with varying glycerol-propylene glycol loadings; and

FIG. 9 is a graphical depiction overlaying ion current curves for glycerol for beaded tobacco samples with varying glycerol-propylene glycol loadings;

FIG. 10 is a graphical depiction overlaying thermogravimetric analysis thermograms for aerosol forming material mixtures; and

FIG. 11 is a graphical depiction overlaying thermogravimetric analysis thermograms for hand sheet substrates impregnated with aerosol forming material mixtures.

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.

The term "about" used throughout this specification is used to describe and account for small fluctuations. For example, the term "about" can refer to less than or equal to ±10%, such as less than or equal to ±5%, less than or equal to ±2%, less than or equal to ±1%, less than or equal to ±0.5%, less than or equal to ±0.2%, less than or equal to ±0.1% or less than or equal to ±0.05%. All numeric values herein

are modified by the term "about," whether or not explicitly indicated. A value modified by the term "about" of course includes the specific value. For instance, "about 5.0" must include 5.0.

Reference to "dry weight percent" or "dry weight basis" refers to weight on the basis of dry ingredients (i.e., all ingredients except water). All weight percent values herein are dry weight percent unless otherwise indicated.

As described hereinafter, example embodiments of the present disclosure relate to an aerosol generating component comprising a substrate two or more aerosol forming materials, including a first aerosol forming material and a second aerosol forming material, wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both. Further example embodiments of the present disclosure relate to an aerosol delivery device comprising the aerosol generating component as disclosed herein; a heat source configured to heat the aerosol forming materials impregnated 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.

Aerosol Generating Components and Aerosol Delivery Devices

Some embodiments of aerosol generating components according to the present disclosure use electrical energy to heat a material to form an inhalable substance (e.g., electrically heated tobacco products). Other embodiments of aerosol generating components according to the present disclosure use an ignitable heat source to heat a material (preferably without combusting the material to any significant degree) to form an inhalable substance (e.g., carbon heated tobacco products). Preferably, the material is heated without combusting the material to any significant degree. 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 preferred 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 preferred systems results in the production of vapors resulting from volatilization or vaporization of certain components incorporated therein. In some example embodiments, components of aerosol delivery devices may be characterized as electronic cigarettes, and those electronic cigarettes most preferably incorporate tobacco and/or components derived from tobacco, and hence deliver tobacco derived components in aerosol form.

Aerosol generating components of certain preferred 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.

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 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 nanocellulose substrate 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).

In other embodiments, aerosol generating components of the present disclosure may generally include an ignitable heat source configured to heat a substrate material. 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. In various aspects, the heat source may be capable of generating heat to aerosolize a substrate material that comprises, for example, a substrate material associated with an aerosol forming materials, an extruded structure and/or substrate, tobacco and/or a tobacco related material, such as a material that is found naturally in tobacco that is isolated directly from the tobacco or synthetically prepared, in a solid or liquid form (e.g., beads, sheets, shreds, a wrap), or the like.

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.

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 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 than 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 (as well as, in some embodiments, one or more flavorants, medicaments, or the like that may likewise be provided for delivery to a user) 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. Preferably, 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 preferably 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, a preferred 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., filed October 21, 2015, 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 (e.g., 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., filed October 13, 2015, 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** may include a substrate portion **110**. As will be discussed in more detail below, in various embodiments the substrate portion **110** may comprise various materials impregnated with the aerosol forming materials. 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 source member, 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.

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.

As will be discussed in more detail below, the presently disclosed 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 preferably 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 source member 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 present disclosure 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 source member **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 source member may be received in the receiving cavity wherein one or more components of the aerosol source member 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. No. 15/799,365, filed on October 31, 2017, and titled *Induction Heated Aerosol Delivery Device*, which is incorporated herein by reference in its entirety.

Substrate

As noted above, in various embodiments the substrate portion **110** may comprise a variety of substrate materials impregnated with two or more aerosol forming materials. In some embodiments, the substrate comprises tobacco-derived fibers, hemp, wood or wood-derived fibers, or a combination thereof.

In various implementations, the tobacco-derived fibers may comprise a milled tobacco material. Tobacco materials that may be useful in the present disclosure can vary and may include, for example, flue-cured tobacco, burley tobacco, Oriental tobacco or Maryland tobacco, dark tobacco, dark-fired tobacco and *Rustica* tobaccos, as well as other rare or specialty tobaccos, or blends thereof. Tobacco

materials also can include so-called "blended" forms and processed forms, such as processed tobacco stems (e.g., cut-rolled or cut-puffed stems), volume expanded tobacco (e.g., puffed tobacco, such as dry ice expanded tobacco (DIET), preferably in cut filler form), reconstituted tobaccos (e.g., reconstituted tobaccos manufactured using paper-making type or cast sheet type processes). Various representative tobacco types, processed types of tobaccos, and types of tobacco blends are set forth in U.S. Pat. Nos. 4,836,224 to Lawson et al.; 4,924,888 to Perfetti et al.; 5,056,537 to Brown et al.; 5,159,942 to Brinkley et al.; 5,220,930 to Gentry; 5,360,023 to Blakley et al.; 6,701,936 to Shafer et al.; 7,011,096 to Li et al.; and 7,017,585 to Li et al.; 7,025,066 to Lawson et al.; U.S. Pat. App. Pub. No. 2004-0255965 to Perfetti et al.; PCT Pat. App. Pub. No. WO 02/37990 to Bereman; and Bombick et al., Fund. Appl. Toxicol., 39, p. 11-17 (1997); which are incorporated herein by reference in their entireties. Further examples of tobacco compositions that may be useful are disclosed in U.S. Pat. No. 7,726,320 to Robinson et al., which is incorporated herein by reference in its entirety. In some implementations, the milled tobacco material may comprise a blend of flavorful and aromatic tobaccos. In another implementation, the tobacco material may comprise a reconstituted tobacco material, such as described in U.S. Pat. No. 4,807,809 to Pryor et al.; U.S. Pat. No. 4,889,143 to Pryor et al. and U.S. Pat. No. 5,025,814 to Raker, the disclosures of which are incorporated herein by reference in their entirety. Additionally, a reconstituted tobacco material may include a reconstituted tobacco paper for the type of cigarettes described in Chemical and Biological Studies on New Cigarette Prototypes that Heat Instead of Burn Tobacco, R. J. Reynolds Tobacco Company Monograph (1988), the contents of which are incorporated herein by reference in its entirety.

In certain embodiments, the substrate comprises a reconstituted tobacco material, using, for example, various casting and paper-making techniques known in the art. The reconstituted tobacco material can include wood pulp, tobacco fibers, botanicals, or other cellulose components. In some embodiments, the addition of a nanocellulose material to the reconstituted tobacco material can serve to enhance both absorbency and mechanical strength of the resulting material. Reconstituted tobacco materials, and methods of providing such materials, are set forth in U.S. Pat. Nos. 4,674,519 to Keritsis et al.; 4,807,809 to Pryor et al.; 4,889,143 to Pryor et al.; 4,941,484 to Clapp et al.; 4,972,854 to Kiernan et al.; 4,987,906 to Young et al.; 5,025,814 to Raker; 5,099,864 to Young et al.; 5,143,097 to Sohn et al.; 5,159,942 to Brinkley et al.; 5,322,076 to Brinkley et al.; 5,339,838 to Young et al.; 5,377,698 to Litzinger et al.; 5,501,237 to Young; and 6,216,707 to Kumar; each of which is incorporated herein by reference in its entirety.

In some embodiments, the substrate comprises, on a weight basis, from about 0 to about 80% tobacco-derived fibers, or from about 0 to about 40% of tobacco-derived fibers, or from about 20 to about 40% tobacco-derived fibers. In some embodiments, the substrate comprises for example, about 0%, about 5%, about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, about 40%, about 45%, about 50%, about 55%, about 60%, about 65%, about 70%, about 75%, or about 80% tobacco-derived fibers.

In some implementations, the substrate may comprise a plant-derived non-tobacco material, including, but not limited to, hemp, flax, sisal, rice straw, esparto, and/or a cellulose pulp material. In various other implementations, the substrate material may comprise reconstituted tobacco by itself or combined with other fibrous materials. Some example manners and methods for providing a reconstituted tobacco sheet, including 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. 6,216,707 to Kumar; each of which is incorporated herein by reference in its entirety. In some instances, processed tobaccos, such as certain types of reconstituted tobaccos, can be employed as longitudinally extending strands. See, for example, the type of configuration set forth in U.S. Pat. No. 5,025,814 to Raker, which is incorporated herein by reference in its entirety. In addition, certain types of reconstituted tobacco sheets can be formed, rolled, or gathered into a desired configuration. 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 like the cellulose fibers in tobacco cast sheet) or structured (e.g., a wire mesh).

In some embodiments, the substrate comprises, on a weight basis, from about 0 to about 5% of wood fibers or wood-derived fibers, for example, about 0%, about 1%, about 2%, about 3%, about 4%, or about 5% wood fibers or wood-derived fibers.

In some embodiments, the substrate portion **110** 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 portion **110,** 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.

As noted, the substrate portion **110** 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 some embodiments, the substrate further comprises one or more binders. In some embodiments, the one or more binders are selected from alginates, cellulose derivatives, starches, gums, dextrans, carrageenan, calcium carbonate, or 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 one or more binders is an alginate, such as ammonium alginate, propylene glycol alginate, potassium alginate, and sodium alginate. Alginates, and particularly high viscosity alginates, may be employed in conjunction with controlled levels of free calcium ions. In some embodiments, the substrate comprises, on a weight basis, from about 0 to about 10% of an alginate, for example, about 0%, about 1%, about 2%, about 3%, about 4% about 5%, about 6%, about 7%, about 8%, about 9%, or about 10% alginate.

In some embodiments, the one or more binders is or comprises one or more cellulose derivatives (e.g., a single cellulose derivative or a combination of several cellulose derivatives, such as two or three, for example). In some embodiments, the substrate comprises, on a weight basis, from about 0 to about 5% of the one or more cellulose derivatives, for example, about 0%, about 1%, about 2%, about 3%, about 4%, or about 5% of the one or more cellulose derivatives. It is to be understood that in embodiments where the substrate comprises more than one cellulose derivative, the stated weight basis of the one or more cellulose derivatives of from about 0% to about 5% reflects the total weight of the combination of cellulose derivatives

In some embodiments, the cellulose derivative comprises a nanocellulose material. As used herein, "nanocellulose material" refers to cellulose materials having at least one average particle size dimension in the range of about 1 nm to about 100 nm. Although larger cellulose material sizes could be used, a reduction in aerosol forming material loading would likely result. As a non-limiting example, a suitable nanocellulose material may be a fibrous material prepared from any variety of cellulose-containing materials, such as wood (e.g., eucalyptus trees), grasses (e.g., bamboo), cotton, tobacco, algae, and other plant-based materials, wherein the fiber is further refined such that a nano-fibrillated cellulose fiber is produced. In various embodiments, the nanocellulose material can contain one or more of

tobacco-derived nanocellulose fibers and/or non-tobacco-derived nanocellulose fibers, optionally in combination with one or more additional cellulose materials, such as tobacco-derived cellulosic pulp and/or wood pulp-based cellulose fibers. In some embodiments, the binder material may comprise nanocellulose derived from a tobacco or other biomass.

In some embodiments, the one or more cellulose derivatives is a chemically modified cellulose derivative. Suitable chemically modified cellulose derivatives include hydroxypropylcellulose, such as Klucel H from Aqualon Co.; hydroxypropylmethylcellulose, such as Methocel K4MS from The Dow Chemical Co.; hydroxyethylcellulose, such as Natrosol 250 MRCS from Aqualon Co.; microcrystalline cellulose, such as Avicel from FMC; methylcellulose, such as Methocel A4M from The Dow Chemical Co.; and sodium carboxymethylcellulose, such as CMC 7HF and CMC 7H4F from Hercules Inc.

In some embodiments, the one or more binders is a starch. In some embodiments, the substrate comprises, on a weight basis, from about 0 to about 30% of a starch, from about 0 to about 15% of a starch; or from about 20 to about 40% of a starch. In some embodiments, the substrate comprises, for example, about 0%, about 5%, about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, or about 40% of a starch. Suitable starches include corn starch, rice starch, and modified food starches. In some other embodiments, the binder is rice starch. In some embodiments, the one or more binders is a dextran. In some other embodiments, the binder may include a cyclodextrin.

In some embodiments, the one or more binders is a gum. Suitable gums include xanthan gum, guar gum, gum Arabic, locust bean gum, and gum tragacanth.

In some embodiments, the one or more binders is a carrageenan.

In some embodiments, the one or more binders is calcium carbonate. In some embodiments, the substrate comprises, on a weight basis, from about 0 to about 60% of calcium carbonate, from about 45 to about 60% of calcium carbonate; from about 40 to about 60% of calcium carbonate; or from about 5 to about 15% of calcium carbonate. In some embodiments, the substrate comprises, for example, about 0%, about 5%, about 10%, about 15%, about 20%, about 25%, about 30%, about 35%, about 40%, about 45%, about 50%, about 55%, or about 60% calcium carbonate.

In some embodiments, the substrate comprises, on a weight basis, from about 0 to about 60% of calcium carbonate; from about 0 to about 10% of an alginate; from about 0 to about 5% of one or more cellulose derivatives; from about 0 to about 30% of a starch; from about 0 to about 5% of wood pulp; and from about 0 to about 80% of tobacco-derived fibers.

In some embodiments, the substrate comprises, on a weight basis, from about 0 to about 5% of calcium carbonate; from about 1% to about 5% of wood pulp; and from about 70 to about 80% of tobacco-derived fibers.

In some embodiments, the substrate comprises, on a weight basis, from about 45 to about 60% of calcium carbonate; from about 0 to about 10% of an alginate; from about 0 to about 5% of one or more cellulose derivatives; from about 0 to about 15% of a starch; from about 0 to about 5% of wood pulp; and from about 0 to about 40% of tobacco-derived fibers.

In some embodiments, the substrate comprises, on a weight basis, from about 40 to about 60% of calcium carbonate; from about 0 to about 10% of an alginate; from about 0 to about 5% of one or more cellulose derivatives; from about 0 to about 15% of a starch; from about 0 to about 5% of wood pulp; and from about 0 to about 40% of tobacco-derived fibers.

In some embodiments, the substrate comprises, on a weight basis, from about 5 to about 15% of calcium carbonate; from about 1 to about 5% of one or more cellulose derivatives; from about 20 to about 40% of a starch; and from about 20 to about 40% of tobacco-derived fibers.

In some embodiments, the substrate comprises tobacco-derived fibers, wood-derived fibers, or a combination thereof, and one or more binders. In some embodiments, the one or more binders are selected from alginates, cellulose derivatives, starches, gums, dextrans, carrageenan, calcium carbonate, or combinations thereof.

In some embodiments, the substrate comprises, on a weight basis, from about 40 to about 70% by weight of tobacco-derived fibers; from about 10 to about 15% by weight of a cellulose derivative; and from about 5 to about 10% by weight of wood pulp. In some embodiments, the cellulose derivative is carboxymethylcellulose.

The moisture (e.g., water) content of the substrate may vary. In some embodiments, the substrate comprises water in an amount by weight of up to about 10%, based on the total dry weight of the impregnated substrate (e.g., the substrate including the aerosol forming materials after drying to remove excess water added during processing).

In some embodiments, the substrate is in particulate form, shredded form, film form, paper process sheet form, cast sheet form, bead form, granular rod form, or extrudate form. In various embodiments, the form of the substrate portion **110** may include gels, shreds, films, suspensions, extrusions, shavings, capsules, and/or particles (including pellets, beads, strips, or any desired particle shape of varying sizes) and combinations thereof. In some embodiments, the substrate is formed into a substantially cylindrical shape.

In some embodiments, the substrate is prepared using paper process technology, and the resulting sheet may be further reduced into cut rag or strips for inserting into the substrate-containing segment of an aerosol delivery device. The preparative method generally comprises the hot water extraction (60-90°C) of tobacco leaves, stems, scraps, or dust for a period of time. This may be followed by separation (centrifugal and/or filter) into a weak extract containing solubles and a solids portion containing unrefined fibers. The weak extract may then be concentrated into a >20% solids (w/v) extract, by, for example, vacuum evaporation or other means. Optionally, one or more of the two or more aerosol formers as disclosed herein may be added and thoroughly mixed to obtain a homogenous mix. To the tobacco solids may be added water and pre-pulped wood fibers, and the materials may again be refined to fibrillate the tobacco fibers. The refined tobacco pulp may then be put through a Fourdrinier screen to produce a non-woven web or paper. The web may then be dried to 45-55% moisture content. The concentrated extract containing the optional aerosol forming materials may then be added back to the web and dried down to

8-10% moisture. Optionally, an inert filtering aid may be added to the pulp before web formation on the Fourdrinier screen.

In a second embodiment, cast sheet technology may be used to make a flat sheet. The cast sheet generally comprises a binder material, an inert filler, optionally one or more of the two or more aerosol formers, wood derived fibers, and optionally a botanical, an active ingredient, and/or tobacco or a tobacco-derived material, each as described herein. For example, in some embodiments the fibrous material, one or more of the two or more aerosol forming materials as disclosed herein, and a binder may be blended together to form a slurry, which may be cast onto a surface (such as, for example, a moving belt). The cast slurry may then experience one or more drying and/or doctoring steps such that the result is a relatively consistent thickness cast sheet. 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. In some embodiments, the flat sheet may further be reduced into cut rag or strips for inserting into the substrate-containing segment of an aerosol delivery device. The cast sheet may also be gathered or rolled into rod for insertion into the substrate-containing segment of an aerosol delivery device.

In a third embodiment, the substrate may be prepared by granular extrusion followed by spheronization or marumerization to produce round or ovoid shaped beads, or hair-like rods. The granular extrusion formulation is similar to that of the cast sheet formulation, except that an alternate or additional binder (e.g., a cellulose derivative) is used therein.

In a fourth embodiment, the substrate may be prepared by extrusion followed by cutting or sizing to provide multiple size and/or shaped substrate pieces. The extrusion formulation is similar to that of the granular extrusion formulation, but using yet another binder combination (e.g., a combination of cellulose derivatives).

In any of the previous embodiments, the entire quantity of aerosol forming materials may be added prior to casting, extrusion, or the like, to form the aerosol generating component as disclosed herein. Alternatively, or in addition, a portion or all of the aerosol forming materials may be impregnated into the substrate post-formation (e.g., one or more aerosol forming materials may be sprayed or otherwise disposed in or on the substrate material to form the aerosol generating component as disclosed herein.

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 in sheet form **120**. With reference to the description above, in the depicted embodiment, the

substrate sheet **120** comprises a film or layer as disclosed herein. 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.

For example, 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 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.

Aerosol forming materials

Aerosol generating components as disclosed herein comprise a substrate impregnated with two or more aerosol forming materials, including a first aerosol forming material and a second aerosol forming material, wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both. As used herein, reference to "boiling point" means the temperature at which the vapor pressure of a liquid equals the pressure surrounding the liquid and the liquid changes into a vapor. In referring to boiling points herein, reference to the pressure surrounding the liquid is standard atmospheric pressure (i.e., 760 mm Hg).

Without wishing to be bound by theory, it is believed that the presence of two or more distinct aerosol forming materials, each having a different volatility (e.g., boiling point), allows greater control over aerosol formation when used in aerosol generating devices. Controlling the volume and density of the aerosol, and optimizing the timing of aerosol formation from an aerosol generating device relative to the application of heat by utilizing two or more aerosol forming materials may lead to an enhanced consumer experience relative to the use of a single aerosol forming material. For example, combinations of two or even three or more different aerosol forming materials having different volatilities may provide more consistent delivery of aerosol throughout the usage of a device or article comprising such mixtures of aerosol generating materials. Particularly, such combinations may provide less variation in quantity of aerosol produced from one puff to the next over the use of the article or device as described herein.

Further, it has been found according to the present disclosure that the physical properties of substrates are impacted by the nature of the aerosol forming material loaded therein. For example, certain polyhydric alcohols, or mixtures of aerosol forming materials comprising polyhydric alcohols, were found to increase substrate flexibility. In contrast, certain other aerosol forming materials, for example palmitic acid in the absence of a polyhydric alcohol, provided substrates which were brittle and difficult to process. Accordingly, selection of aerosol forming materials or appropriate combinations thereof may be utilized to avoid brittleness while providing consistent and long-lasting aerosol formation when loaded into a substrate and subjected to heating, as in an aerosol generating device as disclosed herein.

In some embodiments, the aerosol forming materials each have different boiling points, wherein the boiling points range from about 100°C to about 1000°C, for example, from about 100°C, about 150°C, about 200°C, about 250°C, about 300°C, or about 350°C, to about 400°C, about 500°C, about 600°C, about 700°C, about 800°C, about 900°C, or about 1000°C. In some embodiments, the first aerosol forming material has a boiling point of from about 100°C, about 125°C, about 150°C, or about 175°C, to about 200°C, about 225°C, or to about 250°C; and the second aerosol former has a boiling point of from about 250°C, about 275°C, about 300°C, about 325°C, or about 350°C. In some embodiments, the difference in boiling points between the first and second aerosol forming material is at least 50°C, or at least 100°C. In some embodiments, the difference in boiling points between the first and second aerosol forming material is in the range of from about 50°C to about 300°C, for example, about 50°C, about 100°C, about 150°C, about 200°C, about 250°C, or about 300°C.

The first and second aerosol forming materials may be present in various ratios, with either component predominating depending on the intended application. In some embodiments, the aerosol forming materials are present in a ratio by weight of the first aerosol forming material to the second aerosol forming materials from about 100:1 to about 1:100, such as about 100:1, about 95:5, about 90:10; about 80:20, about 70:30, about 60:40, about 50:50; about 40:60, about 30:70, about 20:80, about 10:90; 5:95, or about 1:100. In some embodiments, the aerosol forming materials are present in a ratio by weight of the first aerosol forming material to the second aerosol forming materials from about 10:1 to about 1:10, about 9:1 to about 1:9, about 8:2 to about 2:8, about 7:3 to about 3:7, about 6:4 to about 4:6, or

about 1:1. In some embodiments, the aerosol forming materials are present in a ratio by weight of the first aerosol forming material to the second aerosol forming materials of from about 3:1 to about 1:3. In some embodiments, the ratio by weight of the first aerosol forming material to the second aerosol forming materials weight is about 3:1, about 2:1, about 1:1, about 1:2, or about 1:3. In some embodiments, the ratio by weight of the first aerosol forming material to the second aerosol forming materials is about 1:1.

In some embodiments, the substrate is further impregnated with at least one additional aerosol forming material. The additional aerosol forming materials can have a boiling point which is in the same range as the first aerosol forming material, or the second aerosol forming material, or may be of a different boiling point range. For example, in one non-limiting embodiment, the first and second aerosol forming materials may have boiling points below 350°C, and the boiling point of the additional aerosol forming material(s) may be above about 350°C. In another non-limiting embodiment, the first and second aerosol forming materials may have boiling points above about 175°C, and the boiling point of the additional aerosol forming material(s) may be below about 175°C. In yet another non-limiting embodiment, the first and second aerosol forming materials may have boiling points between about 175°C and about 300°C, and the boiling point of the additional aerosol forming material(s) may be below about 175°C, or above about 300°C.

In some embodiments, each of the first and second aerosol forming materials, and any additional aerosol forming material which may be present, is independently selected from the group consisting of water, polyhydric alcohols, polysorbates, sorbitan esters, fatty acids, fatty acid esters, triacetin, waxes, cannabinoids, terpenes, and sugar alcohols.

In some embodiments, the aerosol forming materials comprise one or more polyhydric alcohols. Examples of polyhydric alcohols include glycerol, propylene glycol, and other glycols such as 1,3-propanediol, diethylene glycol, triethylene glycol, and polyethylene glycols (e.g., PEG molecules with weight average molecular weight range of about 200 to about 2,000 Da).

In some embodiments, the aerosol forming materials comprise 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" (e.g., 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 materials comprise 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).

In some embodiments, the aerosol forming materials comprise 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 materials comprise palmitic acid.

In some embodiments, the aerosol forming materials comprise 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 materials comprise 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.

In some embodiments, the aerosol forming materials comprise one or more cannabinoids. In some embodiments, the cannabinoid comprises cannabidiol (CBD), tetrahydrocannabinol (THC), or a combination thereof.

In some embodiments, the aerosol forming materials comprise one or more terpenes. As used herein, the term "terpenes" refers to hydrocarbon compounds produced by plants biosynthetically from isopentenyl pyrophosphate. Non-limiting examples of terpenes include limonene, pinene, farnesene, and cembrene.

In some embodiments, the aerosol forming materials comprise one or more sugar alcohols. Examples of sugar alcohols include sorbitol, erythritol, mannitol, maltitol, isomalt, and xylitol. Sugar alcohols may also serve as flavor enhancers to certain flavor compounds, e.g., menthol and other volatiles, and generally improve on mouthfeel, tactile sensation, throat impact, and other sensory properties, of the resulting aerosol.

In some embodiments, at least one of the first aerosol forming material and the second aerosol forming material is a polyhydric alcohol. In some embodiments, the first aerosol forming material and the second aerosol forming material are both polyhydric alcohols. In some embodiments, the polyhydric alcohols are glycerol and propylene glycol. The glycerol and propylene glycol may be present in various ratios, with either component predominating depending on the intended application, as disclosed herein above. For example, 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.

In some embodiments, the substrate is further impregnated with at least one additional aerosol former. In some embodiments, the further at least one additional aerosol former is selected from the group consisting of water, polysorbates, sorbitan esters, fatty acids, fatty acid esters, waxes, triacetin, sugar alcohols, cannabinoids, terpenes, and combinations thereof, each as described above. In some embodiments, the first aerosol forming material is glycerol, the second aerosol forming material is propylene glycol, and the further at least one additional aerosol former is water. In some embodiments, the first aerosol forming material is glycerol, the second aerosol forming material is 1,3-propanediol, and the further at least one additional aerosol former is water. In some embodiments, the first aerosol forming material is glycerol, the second aerosol forming material is propylene glycol, and the further at least one additional aerosol former is a polysorbate. In some embodiments, the first aerosol forming material is glycerol, the second aerosol forming material is a sugar alcohol, and the further at least one additional aerosol former is water.

In some embodiments, the substrate is impregnated with two or more aerosol forming materials, including a first aerosol forming material selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, a polyethylene glycol, triacetin, and combinations thereof; and a second aerosol forming material selected from the group consisting of polysorbates, sorbitan esters, fatty acids, fatty acid esters, 1,3-propanediol, triethylene glycol, a polyethylene glycol,triacetin, waxes, cannabinoids, terpenes, and sugar alcohols; wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both.

In some embodiments, the first aerosol forming material is glycerol. In some embodiments, the first aerosol forming material is 1,3-propanediol, triethylene glycol, propylene glycol, or triacetin.

In some embodiments, the second aerosol forming material is 1,3-propanediol, triethylene glycol, palmitic acid, or triacetin. In some embodiments, the second aerosol forming material is selected from the group consisting of palmitic acid, polyethylene glycol 400, sorbitan tristearate, polysorbate 80, and combinations thereof.

In some embodiments, the first aerosol forming material is glycerol, and the second aerosol forming material is 1,3-propanediol, triethylene glycol, palmitic acid, or triacetin.

In some embodiments, the first aerosol forming material is 1,3-propanediol, triethylene glycol, propylene glycol, or triacetin, and the second aerosol forming material is palmitic acid, polyethylene glycol 400, sorbitan tristearate, or polysorbate 80.

In some embodiments, the first aerosol forming material is glycerol, and the second aerosol forming material is palmitic acid. In some embodiments glycerol and palmitic acid are present in a ratio by weight from about 100:1 to about 1:100, such as about 100:1, about 95:5, about 90:10; about 80:20, about 70:30, about 60:40, about 50:50; about 40:60, about 30:70, about 20:80, about 10:90; 5:95, or about 1:100. In some embodiments glycerol and palmitic acid 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, palmitic acid is replaced by one of

the listed aerosol formers including, but not limited to, 1,3-propanediol, triethylene glycol, triacetin, polyethylene glycol, or polysorbate 60.

In some embodiments, the substrate is impregnated with three aerosol formers. The ratios of the three aerosol forming materials may vary. Accordingly, any one of the three aerosol formers may be present in any ratio relative to each of the other two aerosol forming materials. In some embodiments, the three aerosol formers are present in approximately equal amounts. In some embodiments, there is more of one aerosol former relative to the other two aerosol formers. In particular embodiments, the three aerosol formers are present in a ratio by weight of 1:1.5:1.5.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and a third aerosol forming material selected from the group consisting of 1,3-propanediol, triethylene glycol, propylene glycol, triacetin, polyethylene glycol 400, sorbitan tristearate, and polysorbate 80.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid and 1,3-propanediol. In some embodiments the glycerol, palmitic acid and 1,3-propanediol are present in the ratio by weight of 1:1.5:1.5.

In some embodiments, the substrate is impregnated with glycerol, palmitic, and triethylene glycol. In some embodiments, the substrate is impregnated with glycerol, palmitic, and triethylene glycol in a 1:1.5:1.5 ratio by weight.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and propylene glycol. In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and propylene glycol in a 1:1.5:1.5 ratio by weight.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and triacetin. In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and triacetin in a 1:1.5:1.5 ratio by weight.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and polyethylene glycol 400. In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and polyethylene glycol 400 in a 1:1.5:1.5 ratio by weight.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and sorbitan tristearate. In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and sorbitan tristearate in a 1:1.5:1.5 ratio by weight.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and polysorbate 80. In some embodiments, the substrate is impregnated with glycerol, palmitic acid, and polysorbate 80 in a 1:1.5:1.5 ratio by weight.

In some embodiments, the substrate is impregnated with four aerosol formers. The ratios of the four aerosol forming materials may vary. In particular embodiments, the four aerosol formers are present in a ratio by weight of 2:1:1:0.5.

In some embodiments, the substrate is impregnated with glycerol, palmitic acid, 1,3 propanediol, and triacetin. In some embodiments, the substrate is impregnated with glycerol, palmitic acid, 1,3 propanediol, and triacetin in a ratio by weight of 1:0.5:2:1.

In some embodiments, the substrate is loaded with (e.g., incorporated or impregnated with) the aerosol forming materials as described herein. The amount of aerosol forming material that is incorporated (loaded) within the substrate is such that the aerosol generating component provides acceptable sensory and desirable performance characteristics. For example, it is highly preferred that sufficient amounts of aerosol forming material be 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 forming materials within the aerosol generating component (e.g., the impregnated substrate) may be dependent upon factors such as the number of puffs desired per aerosol generating component.

In some embodiments, the substrate is impregnated with the aerosol forming materials at a loading of at least about 5% by weight, at least about 10% by weight, at least about 15% by weight, at least about 20% by weight, at least about 25% by weight, at least about 30% by weight, at least about 35% by weight, at least about 40% by weight, at least about 45% by weight, at least about 50% by weight, at least about 55% by weight, or at least about 60% by weight, based on a total weight of the impregnated substrate. Example ranges of total aerosol forming materials include about 5 to about 60%, about 10 to about 50%, or about 20 to about 40%, such as about 15% to about 55%, about 15% to about 30%, or about 15% to about 25%, based on the total weight of the impregnated substrate. Methods for loading aerosol forming materials 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.

In various embodiments, loading of the substrate with the aerosol forming materials is achieved by impregnating the substrate with the aerosol forming materials, during preparation of the substrate material, after formation, or both. For example, in some embodiments, a first aerosol forming material (e.g., propylene glycol) is added to the substrate forming slurry during making of e.g., a sheet, and a second forming material (e.g., glycerol) is added to the sheet as a top dressing (for example, by spraying) to form the impregnated substrate (i.e., the aerosol generating component). In other embodiments, the first aerosol forming material and the second aerosol forming material are both added to the substrate forming slurry. In some embodiments, further aerosol forming materials may be impregnated in the substrate, either to the substrate forming slurry, or as a top dressing. As one of skill will recognize, multiple permutations of methods for loading the substrate with the aerosol forming materials is possible, depending on the specific substrate material, form, and the like. Accordingly, any such modifications are contemplated herein.

In some embodiments, the substrate is further impregnated with an active ingredient, a flavorant, or a combination thereof. Each of these components is further described herein below.

Active ingredient

In certain embodiments, the substrate is further impregnated with one or more active ingredients. The active ingredient may be a component of the aerosol forming material, or may be impregnated separately. The impregnation may be performed during preparation of the substrate material, after substrate formation, or both.

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, natural medicaments, and naturally occurring substances that can have an effect on humans. Example active ingredients 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 (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). In some embodiments, the active ingredient may be of the type generally referred to as dietary supplements, nutraceuticals, "phytochemicals" or "functional foods". These types of additives are sometimes defined in the art as encompassing substances typically available from naturally-occurring sources (e.g., botanical materials) that provide one or more advantageous biological effects (e.g., health promotion, disease prevention, or other medicinal properties), but are not classified or regulated as drugs.

Non-limiting examples of active ingredients include those falling in the categories of synthetic organic compounds, proteins and peptides, polysaccharides and other sugars, lipids, inorganic compounds, and nucleic acid sequences, having therapeutic, prophylactic, or diagnostic activity. Non-limiting examples of active ingredients include those falling in the categories of botanical ingredients, stimulants, (e.g., caffeine and guarana), amino acids (e.g., taurine, theanine, phenylalanine, tyrosine, and tryptophan) and/or pharmaceutical, nutraceutical, and medicinal ingredients (e.g., vitamins, such as B6, B12, and C, and/or cannabinoids, such as tetrahydrocannabinol (THC) and cannabidiol (CBD)), antioxidants, and nicotine components. The particular choice of active ingredients will vary depending upon the desired flavor, texture, and desired characteristics of the particular product.

The particular percentages of active ingredients present will vary depending upon the desired characteristics of the particular product. Typically, an active ingredient or combination thereof is present in a total concentration of at least about 0.001% by weight of the composition, such as in a range from about 0.001% to about 20%. In some embodiments, the active ingredient or combination of active ingredients is present in a concentration from about 0.1% w/w to about 10% by weight, such as, e.g., from about 0.5% w/w to about 10%, from about 1% to about 10%, from about 1% to about 5% by weight, based on the total weight of the composition. In some embodiments, the active ingredient or combination of active ingredients is present in a concentration of from about 0.001%, about 0.01%, about 0.1% , or about 1%, up to about 20% by weight, such as, e.g., from about 0.001%, about 0.002%, about 0.003%, about 0.004%, about 0.005%, about 0.006%, about 0.007%, about 0.008%, about 0.009%, about 0.01%,

about 0.02%, about 0.03%, about 0.04%, about 0.05%, about 0.06%, about 0.07%, about 0.08%, about 0.09%, about 0.1%, 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%, about 10%, about 11%, about 12%, about 13%, about 14%, about 15%, about 16%, about 17%, about 18%, about 19%, or about 20% by weight, based on the total weight of the composition. Further suitable ranges for specific active ingredients are provided herein below.

Botanical

In some embodiments, the active ingredient comprises one or more non-tobacco botanicals. 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 invention 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, many of which are associated with antioxidant characteristics, include without limitation acai berry, alfalfa, allspice, annatto seed, apricot oil, ashwagandha, bacopa monniera, baobab, basil, bee balm, beet root, wild bergamot, black pepper, blueberries, borage seed oil, bugleweed, cacao, calamus root, catnip, catuaba, cayenne pepper, *Centella asiatica*, chaga mushroom, Chai-hu, chamomile, cherry blossom, chervil, chlorophyll, cinnamon, dark chocolate, citrus, cocoa, comfrey leaf and root, gingko biloba, ginseng, goji berries, grape seed, green tea, black tea, black cohosh, cayenne, chamomile, cloves, cocoa powder, cordyceps, cranberry, curcumin, damiana, dandelion, *Dorstenia arifolia*, *Dorstenia odorata*, echinacea, eucalyptus, fennel, feverfew, *Galphimia glauca*, garlic, ginger, ginseng (e.g., *Panax ginseng*), goldenseal, green tea, grapefruit, *Griffonia simplicifolia*, guarana, gutu kola, hawthorn, hemp, hibiscus flower, honeybush, hops, jasmine, jiaogulan, *Kaempferia parviflora* (Thai ginseng), kava, lavender, lemon balm, lemongrass, licorice, Lion's mane, lutein, maca, matcha, Nardostachys chinensis, marjoram, milk thistle, mints (menthe), oolong tea, orange, oregano, papaya, pennyroyal, peppermint, potato peel, primrose, quercetin, red clover, resveratrol, *Rhizoma gastrodiae, Rhodiola, rooibos*, rooibos (red or green), rose essential oil, rosehip, rosemary, sage, clary sage, savory, saw palmetto, *Sceletium tortuosum*, Schisandra, silybum marianum, Skullcap, spearmint, Spikenard, spirulina, slippery elm bark, sorghum bran hi-tannin, sorghum grain hi-

tannin, Saint John's Wort, sumac bran, terpenes, thyme, tisanes, turmeric, *Turnera aphrodisiaca,* uva ursi, valerian, *Viola odorata*, white mulberry, wild yam root, wintergreen, withania somnifera, yacon root, yellow dock, yerba mate, and yerba santa,

When present, a botanical is typically at a concentration of from about 0.01% w/w to about 10% by weight, such as, e.g., from about 0.01% w/w, about 0.05%, about 0.1%, or about 0.5%, to about 1%, about 2%, about 3%, about 4%, about 5%, about 6%, about 7%, about 8%, about 9%, or about 10%, about 11%, about 12%, about 13%, about 14%, or about 15% by weight, based on the total weight of the composition.

Nicotine component

In some embodiments, the active ingredient comprises a nicotine component. By "nicotine component" is meant any suitable form of nicotine (e.g., free base or salt) for providing systemic absorption of at least a portion of the nicotine present. The source of the nicotine may vary, and may be natural or synthetic. 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, nicotine is in its free base form. Nicotine may be tobacco-derived (e.g., a tobacco extract) or non-tobacco derived (e.g., synthetic or otherwise obtained). In various embodiments, the impregnated substrate may comprise a nicotine component. In various embodiments, the impregnated substrate may not comprise a nicotine component. In some embodiments, the impregnated substrate may comprise a non-tobacco-derived nicotine component.

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 impregnated substrate, such as in a range from about 0.001% to about 10%. 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 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 impregnated 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 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 impregnated substrate. These ranges can also apply to other active ingredients noted herein.

In some embodiments, the substrate of the disclosure can be characterized as completely free or substantially free of nicotine components. By "substantially free of nicotine components" is meant that no nicotine has been intentionally added, beyond trace amounts that may be naturally present in e.g., a botanical 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.

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 some embodiments, the cannabinoid comprises at least tetrahydrocannabinol (THC). In some embodiments, the cannabinoid is tetrahydrocannabinol (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. Notably, CBD has a logP value of about 6.5, making it insoluble in an aqueous environment (e.g., saliva).

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 substrate is no greater than about 1% by weight of the substrate, such as no greater than about 0.5% by weight of the substrate, such as no greater than about 0.1% by weight of the substrate such as no greater than about 0.01% by weight of the substrate.

The choice of cannabinoid and the particular percentages thereof which may be present within the disclosed substrate will vary depending upon the desired characteristics of the substrate.

In some embodiments, the cannabinoid (such as CBD) is present in the substrate 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 the substrate 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.

Terpenes

Active ingredients suitable for use in the present disclosure can also be classified as terpenes, many of which are associated with biological effects, such as calming effects. 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.

Tobacco component

In some embodiments, the active ingredient comprises a tobacco component (e.g., a tobacco extract). In various embodiments, a tobacco material can be treated to extract a soluble component of the tobacco material therefrom. "Tobacco extract" as used herein refers to the isolated components of a tobacco material that are extracted from solid tobacco pulp by a solvent 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.

Typical inclusion ranges for tobacco components can vary depending on the nature and type of the tobacco material and intended use of the aerosol generating component. In some embodiments, the products of the disclosure can be characterized as completely free or substantially free of tobacco components (other than purified nicotine as an active ingredient). For example, certain embodiments can be characterized as having less than 1% by weight, or less than 0.5% by weight, or less than 0.1%, or less than 0.01% by weight of tobacco component, or even 0% by weight of tobacco component.

Flavorant

As noted, the impregnated substrate may also include a flavorant. The active ingredient may be a component of the aerosol forming material, or may be impregnated separately. The impregnation may be performed during preparation of the substrate material, after substrate formation, or both. 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. Flavorants may be natural or synthetic, and the character of the flavors imparted thereby may be described, without limitation, as fresh,

sweet, herbal, confectionary, floral, fruity, or spicy. 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, orange, and lemon), maple, menthol, eucalyptus, mint, peppermint, spearmint, wintergreen, cascarilla, 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, trigeminal sensates, terpenes, and any combinations thereof. As used herein, "trigeminal sensate" refers to a flavoring agent which has an effect on the trigeminal nerve, producing sensations including heating, cooling, tingling, and the like. Non-limiting examples of trigeminal sensate flavoring agents include capsaicin, citric acid, menthol, Sichuan buttons, erythritol, and cubebol. Further non-limiting examples include flavorings and flavor packages of the type and character traditionally used for the flavoring of cigarette, cigar, and pipe tobaccos. See also, Leffingwell et al., Tobacco Flavoring for Smoking Products, R. J. Reynolds Tobacco Company (1972), which is incorporated herein by reference. Flavoring agents may comprise components such as terpenes, terpenoids, aldehydes, ketones, esters, and the like. 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. No. 15/707,461 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 impregnated 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 impregnated substrate.

Aerosol delivery device

As described herein, in another aspect is provided an aerosol delivery device comprising the aerosol generating component as disclosed herein; a heat source configured to heat the aerosol forming

materials impregnated 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.

Although in some embodiments an aerosol generating component and a control body may be provided together as a complete smoking article or pharmaceutical 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 smoking article or pharmaceutical 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, carrying, 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. 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**.

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 below, 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.

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. Preferred 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. No. 15/923,735, filed on March 16, 2018, and titled *Smoking Article with Heat Transfer Component*, 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 an aerosol generating component (e.g., a substrate portion) having one or more aerosolizable components so that the aerosol formed/volatilized by the application of heat from the heat source to the aerosolizable components (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. Additionally, the selection of various aerosol delivery device elements is appreciated upon consideration of commercially available electronic aerosol delivery devices, such as those representative products listed in the background art section of the present disclosure.

Referring back to FIGS. 5 and 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**. Preferably, 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**.

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: Paper Process Preparation of Heat-Not-Burn (HNB) Aerosol Former Substrates

Aerosol Former Substrate 1A (reference substrate)

Tobacco (lamina and stem, 400 lbs) was mixed with ten times its weight of water and extracted in a counter extractor for 1 hour at 70°C. The extractor contents were subsequently separated by centrifugation into a weak tobacco extract liquor (3-4% w/v) and a non-soluble tobacco solids portion. The weak extract liquor was transferred into a vacuum evaporator and concentrated to 23% solids (w/v). Glycerol (75 lbs) was added and the mixture thoroughly mixed to obtain a final liquor composition. Pre-refined wood pulp (25 lbs) was mixed with the tobacco solids and enough water added to bring the mixture to 1% solids (w/v). Total batch weight was 500 lbs. The wood pulp-tobacco solids mixture was refined using a disc refiner to obtain a fibrillated tobacco pulp. The fibrillated tobacco pulp was conveyed

to a head box and drained over a Fourdrinier wire machine to obtain a wet web or base sheet. The base sheet was dried to 40-55% moisture content. The final liquor composition was added back onto the wet web (spray method) and the wet web dried to 8-10% (w/w) moisture content. The resulting sheet was subsequently diced into leaflet pieces.

Aerosol Former Substrates 1Bi and 1Bii (inventive substrates)

Aerosol former substrate 1Bi was prepared similarly to substrate 1A, except that the wood pulp was eliminated and the glycerol was replaced with a 75/25 mixture by weight of glycerol and propylene glycol. For aerosol former substrate 1Bii, calcium carbonate (present as a filler material and drainage aid) was mixed with half of the fibrillated tobacco pulp before forming the wet web. Total batch weight was 300 lbs (150 lbs for each substrate).

Aerosol Former Substrate 1C (inventive substrate)

Aerosol former substrate 1C was prepared similarly to substrate 1A, except glycerol was replaced with a 50/50 mixture by weight of glycerol and propylene glycol. Total batch weight was 300 lbs.

Aerosol Former Substrate 1D (inventive substrate)

Aerosol former substrate 1D was prepared similarly to substrate 1A, except that glycerol was replaced with a 25/75 mixture by weight of glycerol and propylene glycol. Total batch weight was 300 lbs. See Table 1.

Aerosol Former Substrate 1E (reference substrate)

Aerosol former substrate 1E was prepared similarly to substrate 1B, except glycerol was replaced with propylene glycol. Total batch weight was 300 lbs. See Table 1.

Table 1. Formulations of Paper Process HNB Aerosol Former Substrates

	Components, wt%					
Example #	Calcium Carbonate	Wood Pulp	Glycerol	Propylene Glycol	Tobacco lamina/stem	Total
1A	0	5	15	0	80	100%
1Bi	0	5	11.25	3.75	80	100%
1Bii	5	0	11.25	3.75	80	100%
1C	0	5	7.5	7.5	80	100%
1D	0	5	3.75	11.25	80	100%
1E	0	5	0	15	80	100%

Example 2: Cast Sheet Preparation of HNB Aerosol Former Substrates

Aerosol Former Substrate 2A (reference substrate)

Sodium alginate (50 lbs) was slowly added to water (1650 lbs) and hydrated in a high shear mixing tank for 30 minutes under vacuum. In a separate mixing tank, calcium carbonate (250 lbs) was

slowly added to glycerol (100 lbs) and tobacco extract powder (100 lbs), and then mixed gently for 30 min to form a slurry. The hydrated alginate was then mixed with pre-refined wood pulp of zero freeness, and then transferred into the calcium carbonate slurry, followed by mixing for another 30 minutes under moderate mixing speeds and vacuum to obtain a final slurry. The final slurry was then cast onto a 22-inch-wide stainless steel conveyer belt using a casting knife set at 1-3 mm gap opening. The cast material or film was subsequently dried into a flat sheet by conveying the film through a 200-foot convection tunnel dryer comprising multiple heated zones (80-100° C). Total batch weight was 500 lbs. The flat sheet was wound on a bobbin and vacuum sealed in polyethylene bags to prevent moisture adsorption and blocking during shipment. The bobbins were subsequently unwound and the sheet cut into strips (25-20 cuts per square inch).

Aerosol Former Substrate 2B (inventive substrate)

Aerosol former substrate 2B was prepared similarly to substrate 2A, except that glycerol was replaced with a 75/25 mixture by weight of glycerol and propylene glycol, and pre-refined wood pulp of zero freeness was added to the hydrated alginate and mixed for 30 minutes before addition to the calcium carbonate slurry. Total batch weight was 500 lbs. (See Table 2).

Aerosol Former Substrate 2C (inventive substrate)

Aerosol former substrate 2C was prepared similarly to substrate 2A, except glycerol was replaced with a 50/50 mixture by weight of glycerol and propylene glycol. Total batch weight was 300 lbs.

Aerosol Former Substrate 2D (inventive substrate)

Aerosol former substrate 2D was prepared similarly to substrate 2A, except that glycerol was replaced with a 25/75 mixture by weight of glycerol and propylene glycol. Total batch weight was 300 lbs.

Aerosol Former Substrate 2E (reference substrate)

Aerosol former substrate 2E was prepared similarly to substrate 2A, except glycerol was replaced with propylene glycol. Total batch weight was 300 lbs.

Aerosol Former Substrate 2F (reference substrate)

Aerosol former substrate 2F was prepared similarly to substrate 2A, except that sodium alginate was replaced with ammonium alginate as a binder.

Table 2. Formulations of Cast Sheet HNB Aerosol Former Substrates

	Components, wt%							
Ex. #	Na Alginate	NH_4 Alginate	$CaCO_3$	Wood Pulp	Glycerol	Propylene Glycol	Tobacco extract powder	Total
2A	10	0	45	5	20	0	20	100%
2B	10	0	45	5	15	5	20	100%
2C	10	0	45	5	10	10	20	100%

	Components, wt%							
Ex. #	Na Alginate	NH_4 Alginate	$CaCO_3$	Wood Pulp	Glycerol	Propylene Glycol	Tobacco extract powder	Total
2D	10	0	45	5	5	15	20	100%
2E	10	0	45	5	0	20	20	100%
2F	0	10	45	5	20	0	20	100%

Example 3: Preparation of Bead and Granular Rod HNB Aerosol Former Substrates

Aerosol Former Substrate 3A (reference substrate)

Measured quantities of calcium carbonate (35 lbs) and pre-gelatinized rice starch (5 lbs) were added to a model FM 130 D Littleford precision plough mixer. The contents were mixed at 100 rpm for 10 minutes followed by addition of glycerol (20 lbs) and further mixing at 100 rpm for 10 minutes. The mixer was stopped and a pre-made slurry of carboxymethyl cellulose ((CMC), prepared by hydrating carboxymethyl cellulose (5 lbs) with water (17 lbs) in a vessel using a pitched fork propeller for 30 minutes) was added, followed by further mixing at 100 rpm for 20 minutes. The contents of the plough mixer were portioned and transferred into a model MG-55-1 Fuji Paudel multi-grain extruder. The mass was extruded through a 2-3 mm doomed screen die, resulting in multi-grain (hair-like) shaped rods. The rods were subsequently transferred into a model QJ-230T-2 Fuji Paudal laboratory marumerizer. The marumerizer rotating bowl was used to reshape the rods into rounded or spheronized beads. Subsequently, the beads were transferred into a fluidized bed agglomerator (Flo-Coater, Vector Corporation), and finally dried to 10% moisture with 60-70°C heated air. Portions of the extruded rods were also transferred and subsequently dried using the fluidized bed agglomerator. Total batch weight was 50 lb.

Aerosol Former Substrate 3B (inventive substrate)

Aerosol former substrate 3B was prepared similarly to substrate 3A, except glycerol was replaced with a 75/25 mixture by weight of glycerol and propylene glycol. Total batch weight was 50 lbs. See Table 3.

Aerosol Former Substrate 3C (inventive substrate)

Aerosol former substrate 3C was prepared similarly to substrate 3A, except glycerol was replaced with a 50/50 mixture by weight of glycerol and propylene glycol. Total batch weight was 50 lbs.

Aerosol Former Substrate 3D (inventive substrate)

Aerosol former substrate 3D was prepared similarly to substrate 3A, except that the glycerol/propylene glycol ratio was 25/75 mixture by weight. Total batch weight was 50 lbs.

Aerosol Former Substrate 3E (reference substrate)

Aerosol former substrate 3E was prepared similarly to substrate 3A, except glycerol was replaced with propylene glycol. Total batch weight was 50 lbs. See Table 3

Aerosol Former Substrate 3F (reference substrate)

Aerosol former substrate 3F was prepared similarly to substrate 3A, except that rice starch was replaced with more milled tobacco. Total batch weight was 50 lbs.

Table 3. Formulations of Beads and Granular Rod HNB Aerosol Former Substrates

	Components, wt%							
Ex. #	$CaCO_3$	Rice star	CMC	Glycerol	Propylene Glycol	Milled tobacco powder	Mint flav	Total
3A	35	5	5	20	0	350	0	100%
3B	35	5	5	15	5	35	0	100%
3C	35	5	5	10	10	350	0	100%
3D	35	5	5	5	15	35	0	100%
3E	35	5	5	0	20	35	0	100%
3F	35	0	5	20	0	38.5	1.5	100%

Example 4: Preparation of Extruded HNB Aerosol Former Substrates

Aerosol Former Substrate 4A (reference substrate)

Hydroxypropyl methyl cellulose (HPMC; 2.5 lbs) and hydroxypropyl cellulose (HPC; 2.5 lbs) were mixed with glycerol (25 lbs) in a Hobart mixer for 20 min. The mixture was then added to calcium carbonate (10 lbs), pre-gelatinized rice starch (30 lbs), and tobacco powder (30 lbs) in a model FM 130 D Littleford precision plough mixer, and mixed at 100 rpm for 30 minutes. After 30 minutes, the plough mixer contents were commuted into a K-Tron hopper in-line with a twin screw model ZSK-25 Coperion extruder. The hopper contents were subsequently fed into the extruder comprising eleven barrel sections (27-100°C) operated at a 75 rpm screw speed rate. Water (35 lb) was fed into the second barrel of the extruder to facilitate kneading, mixing, and plasticization of the dough. Shaped dies were used (flat sheet, solid rods, rods with center holes or internal apertures, rods with grooved outer edges) to make variously shaped extrudates. Except for the flat sheet extrudate, the obtained extrudates were cut upon exiting the die and immediately dried to 10-12% moisture using an infrared tunnel dryer (model Proj 0115 Glenroe Integrated Energy Delivery Systems). Total batch weight was 100 lbs.

Aerosol Former Substrate 4B (inventive substrate)

Aerosol former substrate 4B was prepared similarly to substrate 4A, except glycerol was replaced with a 50/50 mixture by weight of glycerol and propylene glycol. Total batch weight was 50 lbs.

Aerosol Former Substrate 4C (inventive substrate)

Aerosol former substrate 4C was prepared similarly to substrate 4B, except that the glycerol/propylene glycol ratio was 25/75 mixture by weight, rice starch, HPMC and HPC were reduced

in quantity, and a liquid mint flavoring was added to the glycerol/propylene glycol mixture to impart flavor to the formulation. Total batch weight was 50 lbs.

Table 4. Formulations of Extruded HNB Aerosol Former Substrates

Ex. #	Components, wt%								
	$CaCO_3$	Rice star	HPC	HPMC	Glycerol	Propylene Glycol	Milled tobacco powder	Mint flavor	Total
4A	10	30	2.5	2.5	25	0	30	0	100%
4B	10	30	2.5	2.5	12.5	12.5	30	0	100%
4C	10	28.5	2.0	2.0	7.25	18.75	30	1.5	100%

Example 5. DSC of aerosol forming materials

Several embodiments of liquid aerosol forming materials and mixtures were prepared containing glycerol or propylene glycol (references), and mixtures thereof (inventive) having different ratios. Thermal profiles of these embodiments were measured by Differential Scanning Calorimetry (DSC). DSC measures the amount of energy (enthalpy) absorbed or heat required (heat of vaporization) and the amount of energy released (exotherm) as the aerosol former changes phases (liquid to vapor) during heating. Results of these experiments (Table 5 and Figure 7) indicated that less heat or energy was required (endotherm) to change the aerosol forming material from liquid to aerosol when propylene glycol (PG) was mixed with glycerol (VG) at levels >50%. The latter shows that combining aerosol formers with varying boiling points or vapor pressures can lead to aerosol formation over a wider temperature range compared to each of the individual parts.

Table 5. DSC of aerosol forming materials

Glycerol/ Propylene Glycol ratio	Energy (Joules/g) for vaporization of aerosol former
100:0	1303.5
75:25	1344.9
50:50	1141.2
25:75	1170.1
0:100	1141.8

Example 6. DSC of aerosol generating components

Thermal profiles of embodiments of aerosol generating components within a substrate matrix were measured by DSC. A similar trend in endotherm/enthalpy reduction with increasing PG inclusion in the liquid mixture was observed across the Examples evaluated (Table 6). Generally, the higher the ratio of PG to glycerol (>50%) in any of the matrices (paper recon, cast sheet or beaded product) the lower the enthalpy or heat of vaporization. Data in Table 6 also revealed that aerosol formation was influenced by matrix format, e.g., lower enthalpies for the beaded product.

Table 6. DSC of aerosol generating components

Ex. #	Heat Flow; Endotherm (J/g)	Heat Flow; Exothermi (J/g)
1A	496.3	418.7
1B	496.4	456.2
1C	483.7	433.1
1D	376.1	447.7
1E	424.2	136.4
2A	420.9	302.4
2B	459.6	286.8
2C	490.5	210.3
2D	450.5	210.3
2E	429.5	182.6
3A	131.0	746.0
3B	106.0	713.0
3C	89.0	655.0
3D	81.0	483.0
3E	85.0	354.0

[a]Endotherm – energy absorbed or required to change recon and aerosol former phases.

[b]Endotherm – energy released after recon and aerosol have reached phase-change equilibrium.

Example 7. Thermogravimetric analysis-mass spectrometry (TGA/MS) ion curves for aerosol generating components in a substrate matrix

Ion curve profiles of embodiments of aerosol generating components within a substrate matrix were measured by TGA/MS. Substrate samples were heated from ambient temperature to 250°C (1 min) and then held at 250°C for 4 min. Figure 8 (overlay of ion current curves for glycerol (M/Z 43); paper reconstitution process substrate) and Figure 9 (overlay of ion current curves for glycerol (M/Z 43); beaded substrate) showed wider aerosolized glycerol ion curve distributions over time for the mixed glycerol-PG samples when compared to the glycerol or PG only counterparts. These findings demonstrate the advantage of a using a mixture of two or more aerosol forming materials versus one aerosol forming material for aerosol formation over a period of time.

Example 8. Thermogravimetric analysis for aerosol forming materials.

The weight change of nine aerosol forming material samples when heated from room temperature to 260°C was studied using Thermogravimetric Analysis (TGA). Around 5-10 mg of each sample was weighed for TGA applications. TGA tests were performed on a TA Instruments TGA 5500. The method used in this study applied a temperature program of 500°C/min ramp to 210°C followed by a temperature jump to 260°C to most efficiently ramp the temperature to 260°C without overshooting. The heating procedure allowed the samples to be heated from room temperature to 260°C in one minute and then held in an isothermal condition for an additional 4 minutes. Weight change was monitored between 0 and 1 minute as well as between 1 and 5 minutes. The tests were performed in three replicates. Weight loss

averages of the three replications were calculated and are provided in Table 7. The temperatures of the samples at 1 minute and 5 minutes are also reported in Table 7.

As shown, a number of the tested materials resisted volatilization during the first minute of heating as indicated by relatively low weight loss in the first minute. In particular, glycerol, palmitic acid, PEG400, sorbitan tristearate, and polysorbate 80 all exhibited a weight loss of less than 50% in the first minute. This suggests that these compounds would be useful in a mixture with one more additional aerosol forming materials that volatilize more quickly. Conversely, 1,3-propanediol, triethylene glycol, propylene glycol and triacetin all showed significantly higher volatility in the first minute. Therefore, these compounds could be good candidates for mixing with the less volatile compounds noted above. Such combinations could lead to consistent aerosol volume over a series of puffs, with the higher volatility aerosol forming compounds forming a larger percentage of early puffs and the less volatile compounds forming a larger percentage of later puffs.

Additionally, for the PEG400, sorbitan tristearate, and polysorbate 80 samples, less than 50% of the samples were aerosolized after 5 minutes, suggesting these compounds may be well-suited for aerosol devices that operate at higher temperatures (e.g., about 280-300 °C).

Table 7: Average Weight Loss and Temperatures of Sample Per Time Point of Aerosol Forming Samples.

Aerosol forming material	**Weight Loss (%) 0-1 min**	**Temperature (°C) 1 min**	**Weight Loss (%) 1-5 min**	**Temperature (°C) 5 min**
glycerol	38.8 ± 3.0	260.0 ± 0.4	62.1 ±3.1	260.0 ± 0.0
palmitic acid	27.0 ± 3.5	260.2 ± 0.6	73.3 ± 3.1	260.0 ± 0.0
polyethylene glycol 400 (PEG400)	4.2 ± 0.7	260.5 ± 0.3	38.0 ± 1.7	260.0 ± 0.0
sorbitan tristearate	4.8 ± 0.1	260.0 ± 0.3	11.0 ± 0.1	260.0 ± 0.0
1,3-propanediol	100.6 ± 0.5	259.5 ± 0.5	0.0 ± 0.0	260.0 ± 0.0
triethylene glycol	101.0 ± 1.0	259.3 ± 0.4	-0.1 ± 0.1	260.0 ± 0.0
polysorbate 80	7.7 ± 0.8	260.9 ± 0.0	28.2 ± 1.6	260.0 ± 0.0
propylene glycol	101.3 ± 0.3	259.4 ± 0.1	0.0 ± 0.0	260.0 ± 0.0
triacetin	101.3 ± 0.5	258.7 ± 0.5	-0.1 ±0.0	260.0 ± 0.0

Example 9. Thermogravimetric analysis-mass spectrometry (TGA/MS) for aerosol forming material mixtures

The release profiles of eight aerosol forming material mixture samples according to Table 8 were studied using TGA-MS. All tests were performed on a TA Instrument Discovery TGA 5500 instrument connected with a Discovery Mass Spectrometer. All tests were carried out in high purity nitrogen. The tests were performed in two replicates for confirmation purposes.

Each sample contained the two aerosol forming materials indicated in Table 8 in a 1:1 ratio by weight. About 2-4 mg of each sample was weighed into tared aluminum pans for analysis. The samples were heated using a temperature program of 50°C /min ramp to 210°C, followed by a temperature jump to 260°C. The heating procedure allowed the samples to be heated from room temperature to 260°C in one minute and then held in an isothermal condition for an additional 4 minutes. Ion fragments (according to National Institute of Standards and Technology MS spectra reference) for each sample are listed in Table 8, and were monitored for each mixture sample with a setting of Faraday 7 in a peak jump recipe for the mass spectrometer.

Table 8. Description of samples (mixtures in a 50/50 ratio) and ion fragment M/Z monitored

Sample ID	Aerosol forming material	M/Z
1	glycerol/propylene glycol	43/45
2	glycerol/triacetin	43/103, 145
3	glycerol/triethylene glycol	43/58, 89
4	glycerol/1,3-propanediol	43/57, 58
5	palmitic acid/propylene glycol	41, 57/45
6	palmitic acid /triacetin	41, 57/103, 145
7	palmitic acid /triethylene glycol	41, 57/58, 89
8	palmitic acid /1,3-propanediol	41, 57/57, 58

An overlay of TGA thermograms for all eight samples is provided in Figure 10, from which it was observed that the mixtures with glycerol lost all their weight before 0.75 minutes, and the mixtures with palmitic acid continued to lose some amount of weight after 0.75 minutes. From the TGA curves, it was also observed that all samples tested vaporized within one minute.

The ion currents for the eight samples were smoothed with a setting of 15 in Trios software. It was observed that most of the aerosol forming mixture samples evolved at around or less than one minute, except the mixtures of glycerol/propylene glycol, glycerol/triethylene glycol, and glycerol/1,3-propanediol. Those three mixture samples could be detected at around two minutes. From the early TGA weight loss results, all the weight loss was completed within one minute.

The foregoing data suggest that aerosol forming material mixtures comprising palmitic acid may be useful in providing more consistent aerosol volume delivery over time, leading to less variation from puff to puff in smoking articles including such mixtures.

Example 10. Thermogravimetric analysis-mass spectrometry (TGA/MS) ion curves for aerosol generating materials in a substrate matrix

Ten hand sheet substrate samples containing various mixtures of aerosol formers were prepared according to the formulation provided in Table 9. The aerosol forming materials in each sample are provided in Table 10.

Table 9. Hand sheet substrate sample components

Component	Percent by dry weight
milled tobacco	60
wood pulp	7.5
carboxymethylcellulose 2500	12.5
aerosol forming material	20

The release profiles of the ten hand sheet samples were studied using TGA-MS. All tests were performed on a TA Instrument Discovery TGA 5500 instrument connected with a Discovery Mass Spectrometer. All tests were carried out in high purity nitrogen. The tests were performed in two replicates for confirmation purposes.

About 2-4 mg of each sample was weighed into tared aluminum pans for analysis. The samples were heated using a temperature program of 50°C /min ramp to 210°C, followed by a temperature jump to 260°C. The heating procedure allowed the samples to be heated from room temperature to 260°C in one minute and then held in an isothermal condition for an additional 4 minutes. Ion fragments (according to National Institute of Standards and Technology MS spectra reference) for each sample are listed in Table 10, and were monitored for each mixture sample with a setting of Faraday 7 in a peak jump recipe for the mass spectrometer.

Table 10. Substrate samples comprising aerosol forming materials and ion fragments M/Z monitored

Sample ID	Aerosol forming material (% by dry weight of each)	M/Z
A	Palmitic acid/1,3-Propanediol (10/10)	41, 57/57, 58
B	Palmitic acid//Triethylene glycol (10/10)	41, 57/58, 89
C	Palmitic acid /Triacetin (10/10)	41, 57/103, 145
D	Palmitic acid/Propylene glycol (10/10)	41, 57/45
E	Glycerol/Propylene glycol (10/10)	43/45
F	Palmitic acid (20)	41
G	Palmitic acid/1,3-Propanediol (15/5)	41, 57/57, 58
H	Palmitic acid /1,3-Propanediol (10/10)	41, 57/57, 58
I	Palmitic acid/1,3-Propanediol (5/15)	41, 57/57, 58
J	1,3-Propanediol (20)	57/57, 58

An overlay of TGA thermograms for all ten samples is shown in Figure 11. From the TGA overlay curves, it was observed that the samples lost most of their volatile portion within 1 minute.

With respect to the mass spectroscopy analysis, no ion current signal was observed for tested samples A, B, C, F, I and J, and only small signals were observed for samples D, E, G and H. The lack of signal or small signals of the alternate aerosol former samples could be due to the loss of the aerosol forming material during the drying process in the hand sheet sample making process or before the sample tests. Samples D, E, G, and F demonstrate greater aerosol longevity than the other candidates shown in Table 10.

Example 11. Thermogravimetric analysis-mass spectrometry (TGA/MS) ion curves for aerosol generating materials in a substrate matrix

Eight hand sheet substrate samples containing various mixtures of aerosol formers are prepared in a matrix format according to the formulations provided in Table 11, with all weight percentages being dry weight.

Carboxymethylcellulose (CMC2500) is slowly added to water and hydrated in a high shear mixing tank for 30 minutes under vacuum. In a separate mixing tank, finely milled tobacco is slowly added to the aerosol forming material(s) and water, and then mixed gently for 30 min to form a tobacco-water slurry. The hydrated CMC2500 is then mixed with pre-refined wood pulp of zero freeness, and transferred into the tobacco-water slurry tank, followed by mixing for another 30 minutes under moderate mixing speeds and vacuum to obtain a final slurry.

The final slurry is then cast onto a 22-inch-wide stainless steel conveyer belt using a casting knife set at 1-3 mm gap opening. The cast material (film) is subsequently dried into a flat sheet by conveying the film through a 200-foot convection tunnel dryer comprising multiple heated zones (80-100°C). The flat sheets are wound onto a bobbin and vacuum sealed in polyethylene bags to prevent moisture adsorption and blocking during shipment. The bobbins are subsequently unwound and the sheet cut into strips (25-20 cuts per square inch).

The release profiles of the eight hand sheet samples are studied according the procedure in Example 10.

Table 11. Hand sheet substrate sample components

Material	Sample #							
	1	2	3	4	5	6	7	8
milled tobacco, % by weight	60	60	60	60	60	60	60	60
wood pulp, % by weight	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
carboxymethylcellulose 2500, % by weight	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
palmitic acid, % by weight	10	10	10	10	15	5	0	0
1,3-propanediol, % by weight	10	0	0	0	5	15	10	0
triethylene glycol, % by weight	0	10	0	0	0	0	0	0
triacetin, % by weight	0	0	10	0	0	0	0	0
propylene glycol, % by weight	0	0	0	10	0	0	0	14
glycerol, % by weight	0	0	0	0	0	0	10	6

Example 12. Thermogravimetric analysis for aerosol generating material combinations

A set of sixteen aerosol forming material combinations is prepared and studied by TGA using the procedure of Example 9. The matrix is provided as Table 12. Each of the identified aerosol forming materials is present in the binary mixtures as indicated in a 1:1 ratio by weight. The release profiles of the sixteen samples are studied according the procedure in Example 8.

Table 12. Description of samples in matrix format

		First aerosol forming material			
		1,3-propanediol	triethylene glycol	triacetin	propylene glycol
Second aerosol formi material	palmitic acid	x	x	x	x
	PEG 400	x	x	x	x
	polysorbate 80	x	x	x	x
	glycerol	x	x	x	x

Example 13. Thermogravimetric analysis for aerosol generating materials in a substrate matrix

Six hand sheet substrate samples containing various mixtures of aerosol formers were prepared according to the formulations provided in Table 9. The aerosol forming materials in each sample are provided in Table 13, with all weight percentages being dry weight. The release profiles of the six hand sheet samples were studied using TGA. All tests were performed on a TA Instrument Discovery TGA 5500 instrument. The tests were performed in three replicates for confirmation purposes. Weight loss averages of the three replicates are provided in Table 13.

About 3-5 mg of each sample was weighed into tared aluminum pans for analysis. The samples were heated using a temperature program of 500°C /min ramp to 210°C, followed by a temperature jump to 260°C. The heating procedure allowed the samples to be heated from room temperature to 260°C in one minute and then held in an isothermal condition for an additional 4 minutes. Weight change was monitored from 0 to 5 minutes.

The results showed that most weight loss occurred within the first minute during the fast heating process. In the first minute, the most amount of weight loss occurred in control sample 17A (glycerin; 35.4%), while the least amount of weight loss occurred in sample 41A (glycerin-palmitic acid; 27.8%). This data supports particularly combinations of glycerin with palmitic acid, triethylene glycol, or triacetin for more sustained release of aerosol from the substrate over time, which may be useful in providing less puff-to-puff variation. In contrast, combinations of glycerin with 1,3-propanediol, or glycerin with propylene glycol were nearly indistinguishable from the glycerin control.

Table 13. Hand sheet substrate sample components and average weight loss and temperature per time point

Sample ID	Aerosol forming material (wt%)	Weight Loss % (0-1 min)	Temperature (°C) 1 min	Weight Loss % (1-5 min)	Temperature (°C) 5 min
17A	**Control-** 20% glycerin	35.4 ± 0.8	258.1 ± 0.2	9.8 ±0.4	260.0 ± 0.0
41A	10% glycerin/10% palmitic acid	27.8 ± 0.3	257.7 ± 0.1	9.4 ± 0.3	260.0 ± 0.0
42A	10% glycerin/10% 1,3-propanediol	34.7 ± 0.3	257.8 ± 0.1	7.5 ± 0.3	260.0 ± 0.0
43A	10% glycerin/10% triethylene glycol	31.4 ± 1.2	257.7 ± 0.5	9.9 ± 0.8	260.0 ± 0.0
44A	10% glycerin/ 10% triacetin	30.5 ± 0.5	258.0 ± 0.3	10.1 ± 0.4	260.0 ± 0.0
45A	10% glycerin/ 10% propylene glycol	33.5 ± 1.7	257.8 ± 0.1	9.1 ± 0.3	260.0 ± 0.0

Example 14: Cast Sheet Preparation of HNB Aerosol Former Substrates

A series of six substrates containing various aerosol forming materials was prepared using the components and quantities indicated in Table 14.

Aerosol Former Substrate 14A (reference substrate)

Carboxymethylcellulose (CMC2500; 2.5 lbs) was slowly added to water (100 lbs) and hydrated in a high shear mixing tank for 30 minutes under vacuum. In a separate mixing tank, finely milled tobacco (12 lbs) was slowly added to glycerol (4 lbs) and water (5 lbs), and then mixed gently for 30 min to form a tobacco-water slurry. The hydrated CMC2500 was then mixed with pre-refined wood pulp of zero freeness, and transferred into the tobacco-water slurry tank, followed by mixing for another 30 minutes under moderate mixing speeds and vacuum to obtain a final slurry. The final slurry was then cast onto a 22-inch-wide stainless steel conveyer belt using a casting knife set at 1-3 mm gap opening. The cast material (film) was subsequently dried into a flat sheet by conveying the film through a 200-foot convection tunnel dryer comprising multiple heated zones (80-100°C). Total dry batch weight was 20 lbs. The flat sheet was wound onto a bobbin and vacuum sealed in polyethylene bags to prevent moisture adsorption and blocking during shipment. The bobbins were subsequently unwound and the sheet cut into strips (25-20 cuts per square inch).

Aerosol Former Substrate 14B

Aerosol former substrate 14B was prepared similarly to substrate 14A, except that glycerol was replaced with a 1:1 mixture by weight of glycerol and palmitic acid. Total batch weight was 20 lbs.

Aerosol Former Substrate 14C

Aerosol former substrate 14C was prepared similarly to substrate 14A, except that glycerol was replaced with a 1:1 mixture by weight of glycerol and triethylene glycol. Total batch weight was 20 lbs.

Aerosol Former Substrate 14D

Aerosol former substrate 14D was prepared similarly to substrate 14A, except glycerol was replaced with a 1:1 mixture by weight of glycerol and triacetin. Total batch weight was 20 lbs.

Aerosol Former Substrate 14E (reference)

Aerosol former substrate 14E was prepared similarly to substrate 14A, except glycerol was replaced with a mixture of glycerol and propylene glycol (ratio of 1:1 by weight). Total batch weight was 20 lbs.

Aerosol Former Substrate 14F

Aerosol former substrate 14F was prepared similarly to substrate 14A, except glycerol was replaced with a 1:1.5:1.5 mixture by weight of glycerol, palmitic acid, and 1,3-propanediol. Total batch weight was 20 lbs.

Table 14. Formulations of Cast Sheet HNB Aerosol Former Substrates

Ex. #	Components, weight%								
	CMC 2500	Wood pulp	Milled tobacco	Glycerol	Palmitic acid	1,3-Propane diol	Triethylene glycol	Triacetin	Propylene glycol
14A	12.5	7.5	60.0	20.0	0.0	0.0	0.0	0.0	0.0
14B	12.5	7.5	60.0	10.0	10.0	0.0	0.0	0.0	0.0
14C	12.5	7.5	60.0	10.0	0.0	0.0	10.0	0.0	0.0
14D	12.5	7.5	60.0	10.0	0.0	0.0	0.0	10.0	0.0
14E	12.5	7.5	60.0	10.0	0.0	0.0	0.0	0.0	10.0
14F	12.5	7.5	60.0	5.0	7.5	7.5	0.0	0.0	0.0

CLAIMS

What is claimed is:

1. An aerosol generating component comprising a substrate impregnated with two or more aerosol forming materials, including:

a first aerosol forming material selected from the group consisting of glycerol, propylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, a polyethylene glycol, triacetin, and combinations thereof; and

a second aerosol forming material different from the first aerosol forming material and selected from the group consisting of polysorbates, sorbitan esters, fatty acids, fatty acid esters, 1,3-propanediol, triethylene glycol, a polyethylene glycol, triacetin, waxes, cannabinoids, terpenes, and sugar alcohols;

wherein the first aerosol forming material and the second aerosol forming material each have different boiling points, different vapor pressures, or both; and

wherein the substrate is impregnated with the two or more aerosol forming materials at a loading from about 5 to about 60% by weight, based on the total weight of the impregnated substrate.

2. The aerosol generating component of claim 1, wherein the substrate is impregnated with the two or more aerosol forming materials at a loading from about 15 to about 30% by weight, based on a total weight of the impregnated substrate.

3. The aerosol generating component of claim 1 or 2, wherein a ratio by weight of the first aerosol forming material to the second aerosol forming material is from about 100:1 to about 1:100.

4. The aerosol generating component of any one of claims 1-3, wherein a ratio by weight of the first aerosol forming material to the second aerosol forming material is from about 3:1 to about 1:3.

5. The aerosol generating component of any one of claims 1-4, wherein the second aerosol forming material is selected from the group consisting of palmitic acid, polyethylene glycol 400, sorbitan tristearate, polysorbate 80, and combinations thereof.

6. The aerosol generating component of any one of claims 1-4, wherein the first aerosol forming material is glycerol, and the second aerosol forming material is 1,3-propanediol, triethylene glycol, palmitic acid, or triacetin.

7. The aerosol generating component of any one of claims 1-4, wherein the first aerosol forming material is glycerol, and the second aerosol forming material is palmitic acid.

8. The aerosol generating component of any one of claims 1-4, wherein:

the first aerosol forming material is 1,3-propanediol, triethylene glycol, propylene glycol, or triacetin; and

the second aerosol forming material is palmitic acid, polyethylene glycol 400, sorbitan tristearate, or polysorbate 80.

9. The aerosol generating component of any one of claims 1-4, wherein the substrate is impregnated with glycerol, palmitic acid, and a third aerosol forming material selected from the group consisting of 1,3-propanediol, triethylene glycol, propylene glycol, triacetin, polyethylene glycol 400, sorbitan tristearate, and polysorbate 80.

10. The aerosol generating component of any one of claims 1-4, wherein the substrate is impregnated with a mixture selected from the group consisting of:

glycerol and palmitic acid;
glycerol and 1,3-propanediol;
glycerol and triethylene glycol;
glycerol and triacetin;
1,3-propanediol and palmitic acid;
1,3-propanediol and polyethylene glycol;
1,3-propanediol and polysorbate 80;
triethylene glycol and palmitic acid;
triethylene glycol and polyethylene glycol;
triethylene glycol and polysorbate 80;
triacetin and palmitic acid;
triacetin and polyethylene glycol;
triacetin and polysorbate 80;
propylene glycol and palmitic acid;
propylene glycol and polyethylene glycol; and
propylene glycol and polysorbate 80.

11. The aerosol generating component of claim 10, wherein in each listed mixture, a ratio of the aerosol forming materials is from about 3:1 to about 1:3.

12. The aerosol generating component of any one of claims 1-4, wherein the substrate is impregnated with a mixture comprising glycerol, palmitic acid, and propylene glycol.

13. The aerosol generating component of claim 12, further comprising triacetin.

14. The aerosol generating component of any one of claims 1-13, wherein the substrate further comprises water in an amount by weight of up to about 10%, based on the total dry weight of the impregnated substrate.

15. The aerosol generating component of any one of claims 1-14, wherein the substrate comprises tobacco-derived fibers, wood-derived fibers, plant or plant-derived fibers, synthetic fibers, or a combination thereof, and one or more binders.

16. The aerosol generating component of any one of claims 1-15, wherein the one or more binders are selected from alginates, cellulose derivatives, starches, gums, dextrans, carrageenan, calcium carbonate, or combinations thereof.

17. The aerosol generating component of any one of claims 1-16, wherein the substrate comprises:
from about 40 to about 70% by weight of tobacco-derived fibers;
from about 10 to about 15% by weight of a cellulose derivative; and
from about 5 to about 10% by weight of wood pulp.

18. The aerosol generating component of any one of claims 1-17, wherein the substrate is further impregnated with a flavorant, an active ingredient, or a combination thereof.

19. The aerosol generating component of claim 18, wherein the active ingredient comprises a tobacco component, a non-tobacco botanical, a nicotine component, or a combination thereof.

20. The aerosol generating component of claim 18, wherein the active ingredient comprises a nicotine component.

21. The aerosol generating component of any one of claims 1-20, wherein the substrate is in particulate form, shredded form, film form, paper process sheet form, cast sheet form, bead form, granular form, rod form, or extrudate form.

22. The aerosol generating component of claim 21, wherein the substrate is formed into a substantially cylindrical shape.

23. An aerosol delivery device, comprising:
the aerosol generating component of any one of claims 1-22;
a heat source configured to heat the impregnated substrate to form an aerosol; and

an aerosol pathway extending from the aerosol generating component to a mouth-end of the aerosol delivery device.

24. The aerosol delivery device of claim 23, wherein the heat source comprises either an electrically powered heating element or a combustible ignition source.

25. The aerosol delivery device of claim 24, wherein the heat source is a combustible ignition source comprising a carbon-based material.

26. The aerosol delivery device of claim 24, wherein the heat source is an electrically-powered heating element.

27. The aerosol delivery device of claim 26, further comprising a power source electronically connected to the heating element.

28. The aerosol delivery device of claim 27, further comprising a controller configured to control the power transmitted by the power source to the heating element.

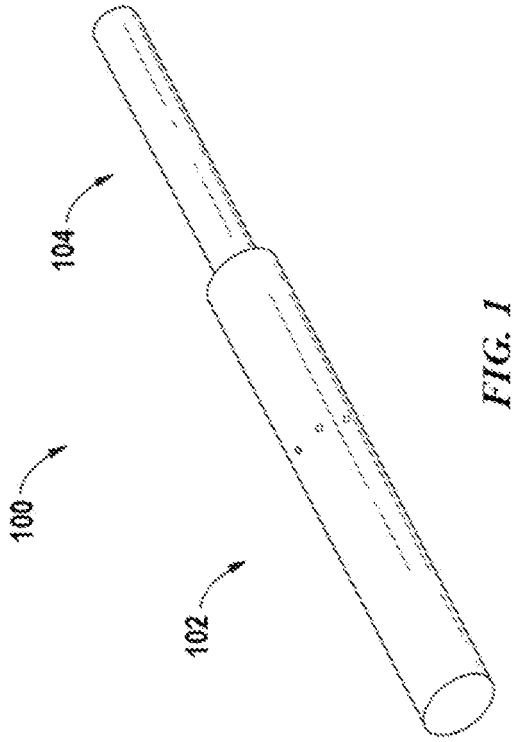


FIG. 1

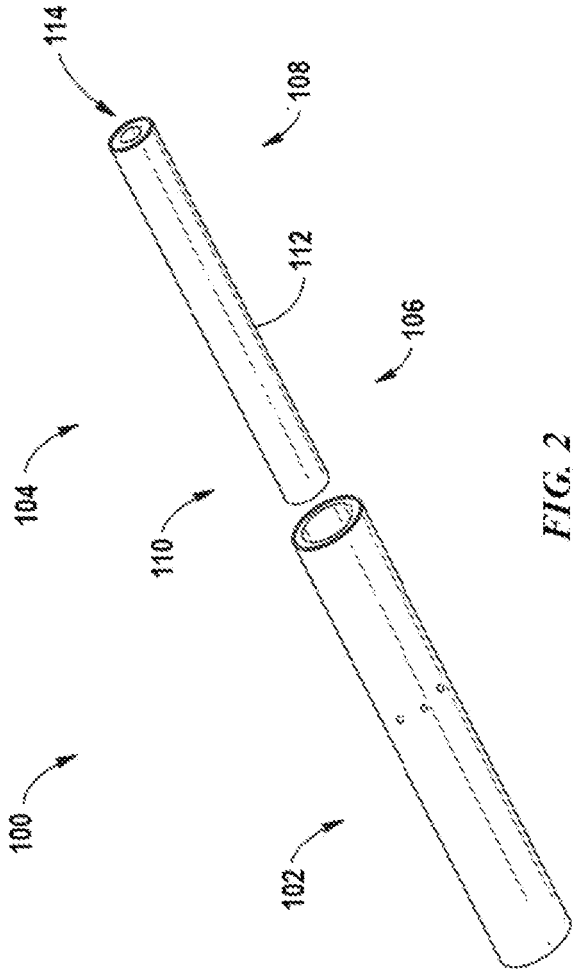


FIG. 2

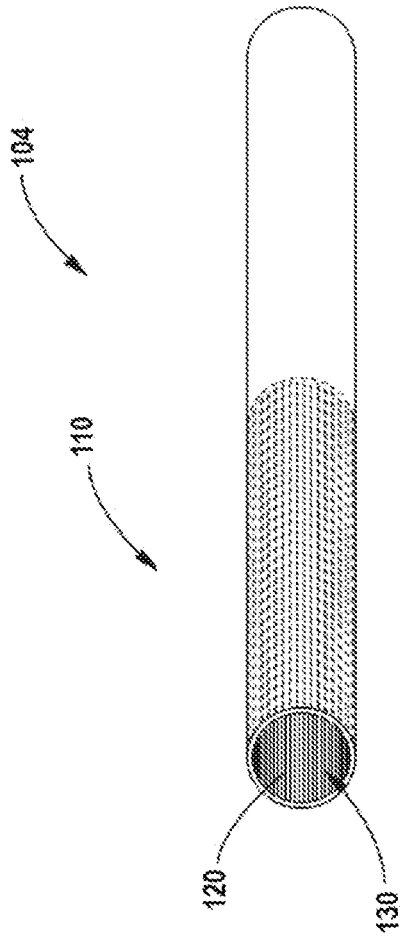


FIG. 3

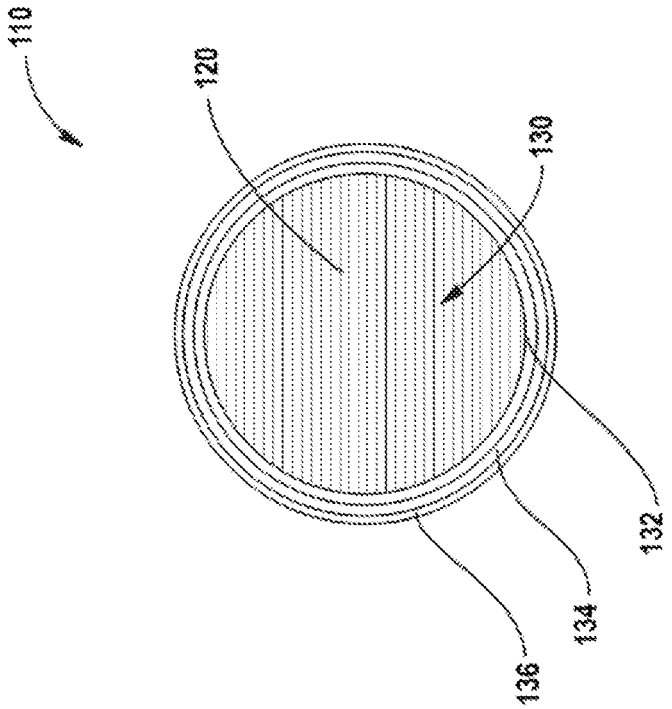


FIG. 4

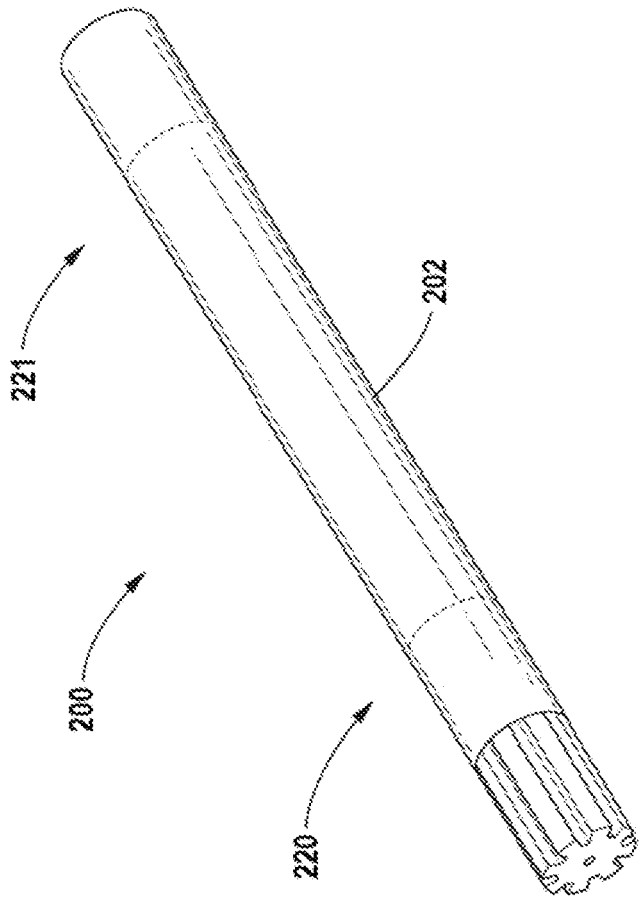


FIG. 5

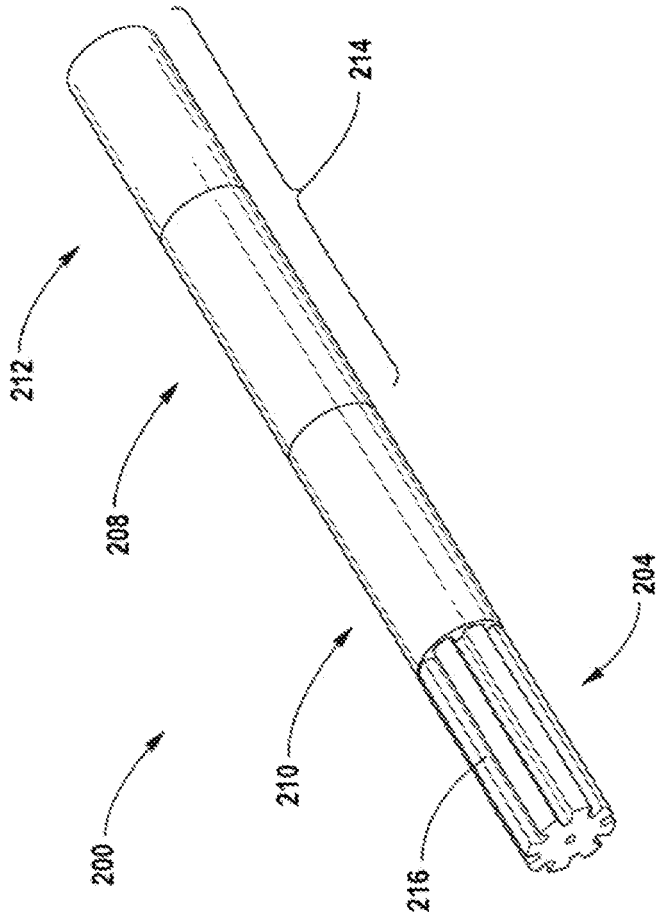


FIG. 6

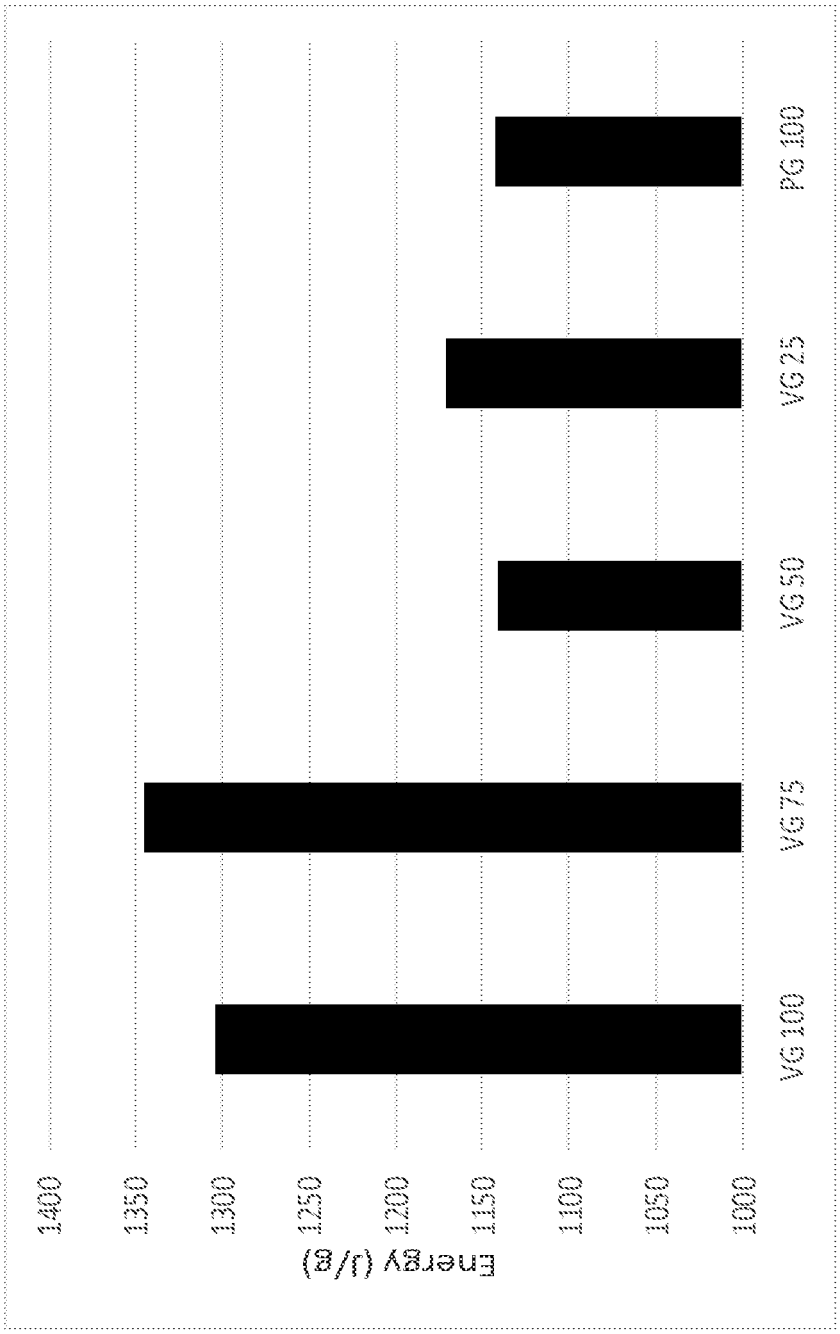

Energy (J/g)
1400
1350
1300
1250
1200
1150
1100
1050
1000
VG 100
VG 75
VG 50
VG 25
PG 100

FIG. 7

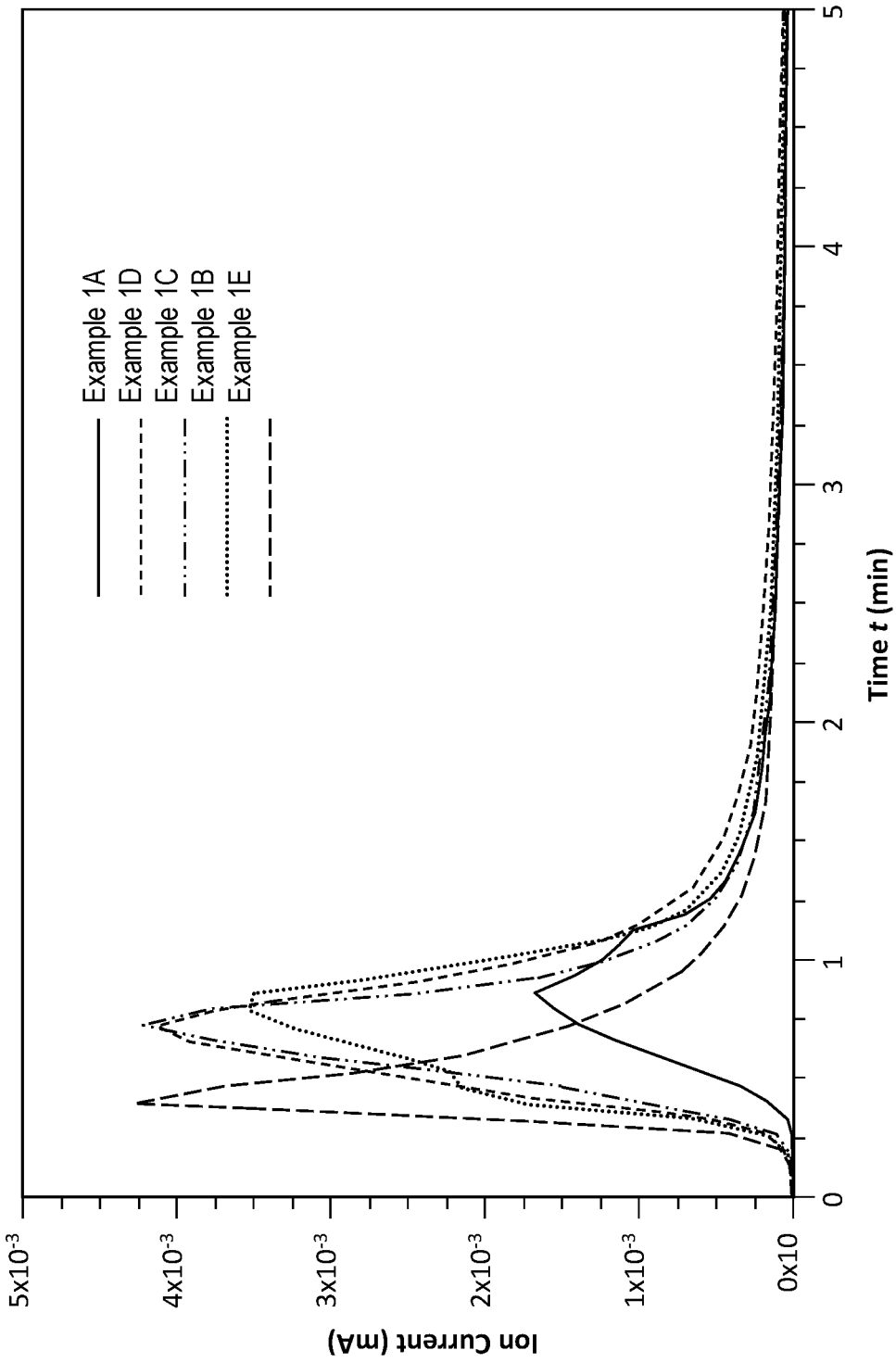

Example 1A
Example 1D
Example 1C
Example 1B
Example 1E
Ion Current (mA)
5x10-3
4x10-3
3x10-3
2x10-3
1x10-3
0x10
0
1
2
3
4
5
Time t (min)

FIG. 8

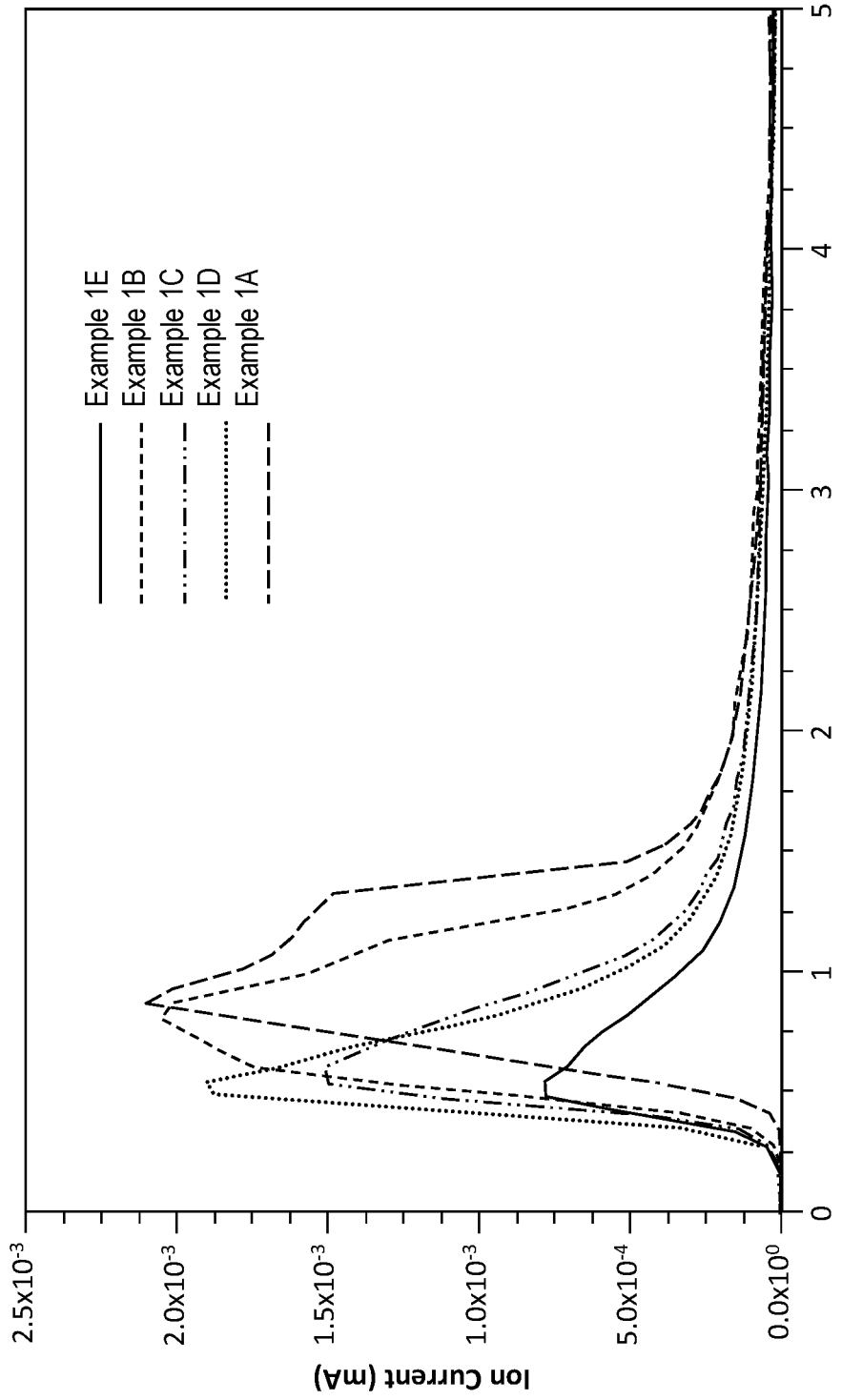

Example 1E
Example 1B
Example 1C
Example 1D
Example 1A
Ion Current (mA)
2.5x10-3
2.0x10-3
1.5x10-3
1.0x10-3
5.0x10-4
0.0x100
Time t (min)
0
1
2
3
4
5

FIG. 9

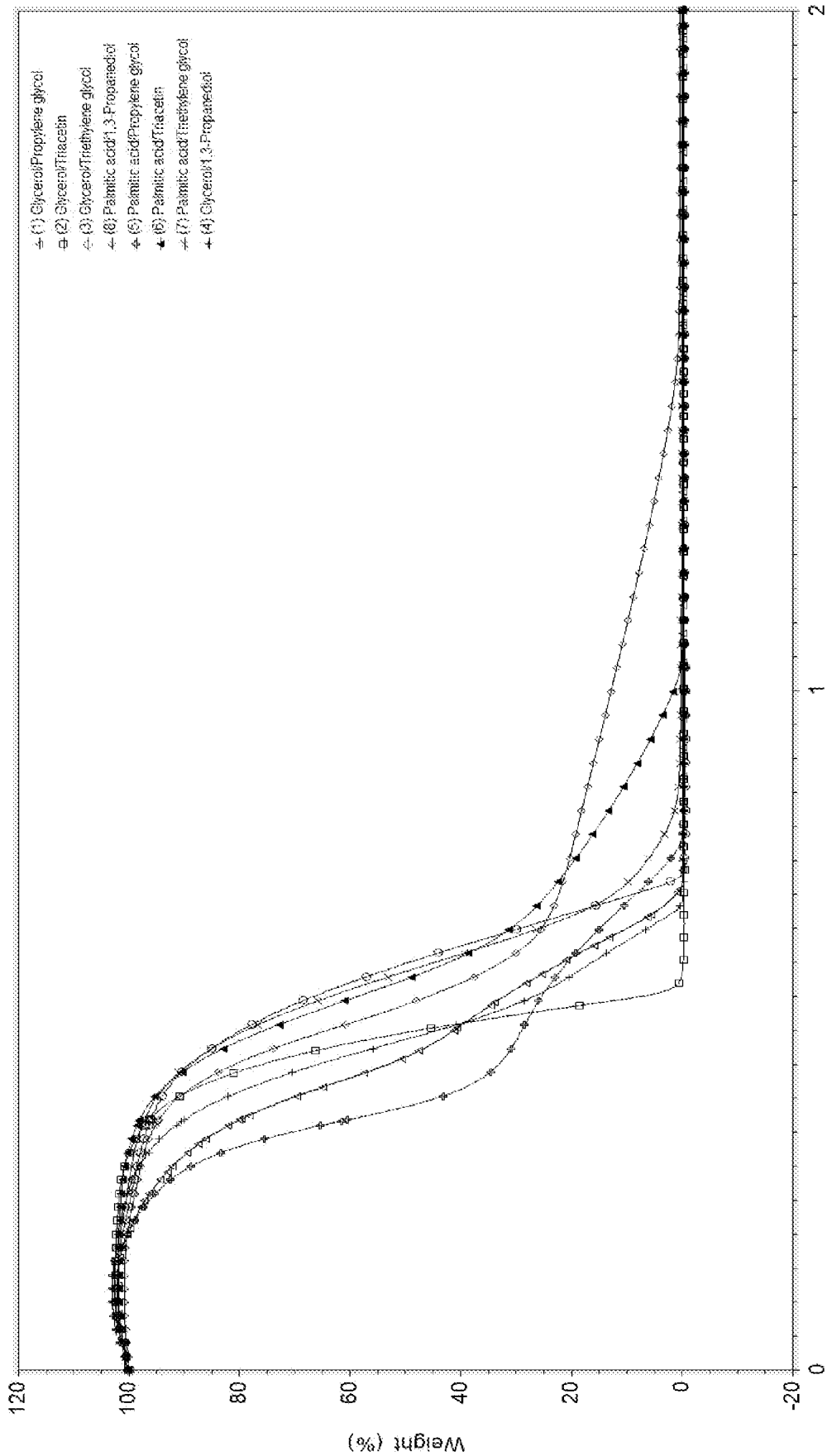

(1) Glycerol/Propylene glycol
(2) Glycerol/Triacetin
(3) Glycerol/Triethylene glycol
(8) Palmitic acid/1,3-Propanediol
(5) Palmitic acid/Propylene glycol
(6) Palmitic acid/Triacetin
(7) Palmitic acid/Triethylene glycol
(4) Glycerol/1,3-Propanediol
120
100
80
60
40
20
0
-20
Weight (%)
0
1
2
Time t (min)

FIG. 10

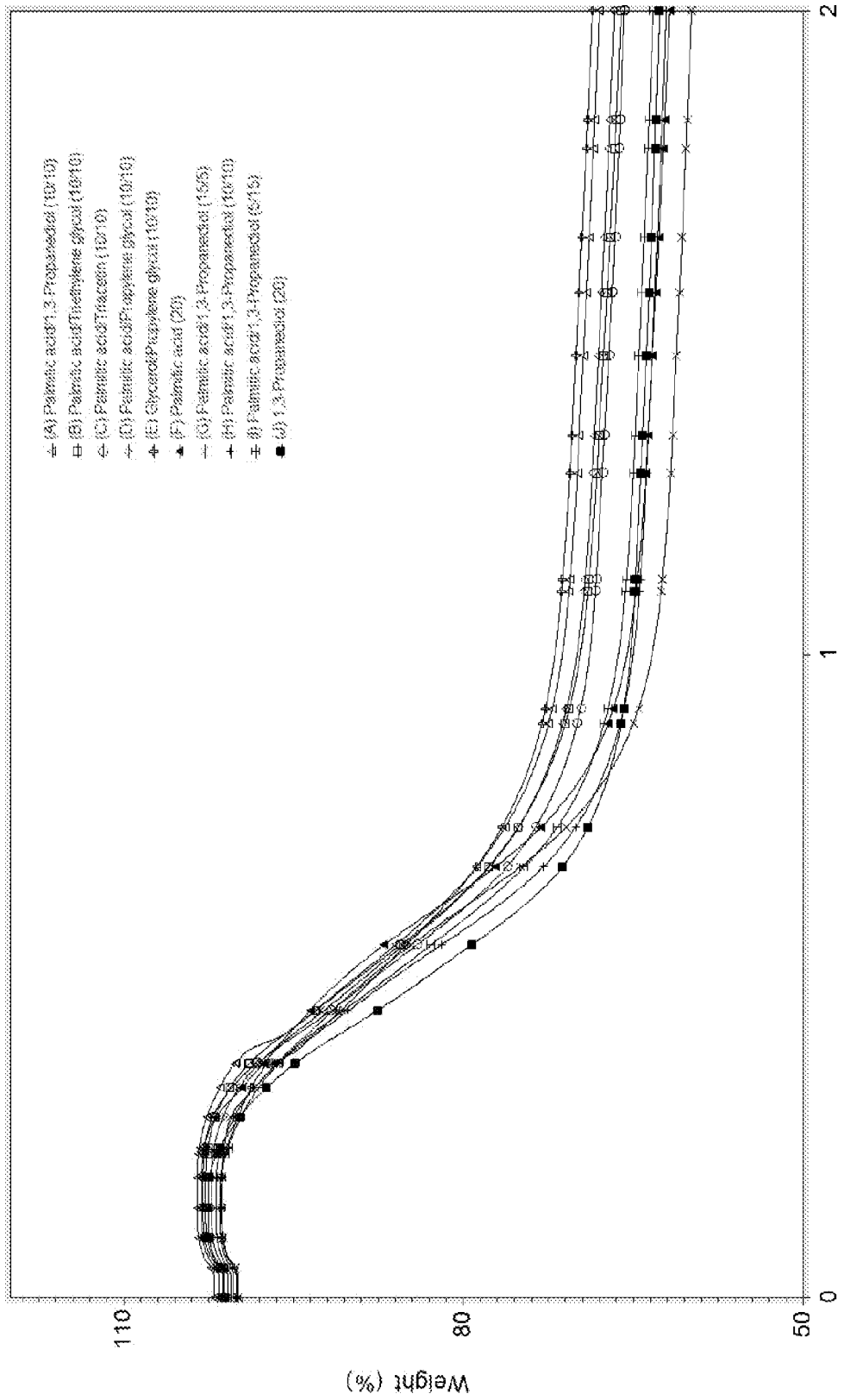

(A) Palmitic acid/1,3-Propanediol (10/10)
(B) Palmitic acid/Triethylene glycol (10/10)
(C) Palmitic acid/Tricaprin (10/10)
(D) Palmitic acid/Propylene glycol (10/10)
(E) Glycerol/Propylene glycol (10/10)
(F) Palmitic acid (20)
(G) Palmitic acid/1,3-Propanediol (15/5)
(H) Palmitic acid/1,3-Propanediol (10/10)
(I) Palmitic acid/1,3-Propanediol (5/15)
(J) 1,3-Propanediol (20)
Weight (%)
110
80
50
0
1
2
Time t (min)

FIG. 11