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(54) **AN AEROSOL-FORMING SUBSTRATE**

(57) An aerosol-forming substrate (1020) for use in an aerosol-generating system (2000). The aerosol-forming substrate (1020) comprises: one or more aerosol formers; hydroxypropylmethyl cellulose; one or more cellulose based strengthening agents; and carboxymethyl cellulose. The aerosol-forming substrate (1020) has an aerosol former content of greater than 30 percent by weight.

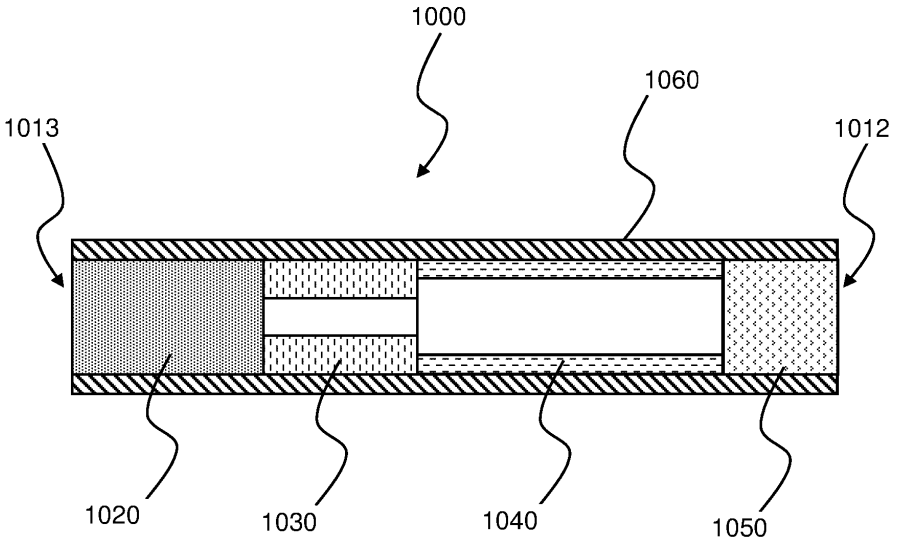

Figure 1

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Description

[0001] The present invention relates to an aerosol-forming substrate comprising hydroxypropylmethyl cellulose and one or more cellulose based strengthening agents.

[0002] Aerosol-generating systems for delivering an aerosol to a user typically comprise an atomiser configured to generate an inhalable aerosol from an aerosol-forming substrate. Some known aerosol-generating systems comprise a thermal atomiser such as an electric heater or an inductive heating device. The thermal atomiser is configured to heat and vaporise the aerosol-forming substrate to generate an aerosol. Typical aerosol-forming substrates for use in aerosol-generating systems are nicotine formulations, which may be liquid nicotine formulations comprising an aerosol former such as glycerine and/or propylene glycol.

[0003] It would be desirable to provide an aerosol-generating article having an aerosol-forming substrate that exhibits increased tensile strength.

[0004] It would also be desirable to provide an aerosol-generating article having an aerosol-forming substrate that exhibits a reduced tendency to melt and form a crust on a part of the aerosol-generating article or a part of the aerosol-generating system.

[0005] There is provided an aerosol-forming substrate for use in an aerosol-generating system. The aerosol-forming substrate may comprise one or more aerosol formers. The aerosol-forming substrate may comprise hydroxypropylmethyl cellulose. The aerosol-forming substrate may comprise one or more cellulose based strengthening agents.

[0006] There is also provided an aerosol-forming substrate for use in an aerosol-generating system, the aerosol-forming substrate comprising: one or more aerosol formers; hydroxypropylmethyl cellulose; and one or more cellulose based strengthening agents.

[0007] There is also provided an aerosol-generating article for use in an aerosol-generating system. The aerosol-generating article may comprise an aerosol-forming substrate. The aerosol-forming substrate may comprise one or more aerosol formers. The aerosol-forming substrate may comprise hydroxypropylmethyl cellulose. The aerosol-forming substrate may comprise one or more cellulose based strengthening agents.

[0008] There is also provided an aerosol-generating article comprising: an aerosol-forming substrate comprising: one or more aerosol formers; hydroxypropylmethyl cellulose; and one or more cellulose based strengthening agents.

[0009] There is also provided an aerosol-generating system comprising: an aerosol-generating device; and an aerosol-generating article. The aerosol-generating article may comprise an aerosol-forming substrate. The aerosol-forming substrate may comprise one or more aerosol formers. The aerosol-forming substrate may comprise hydroxypropylmethyl cellulose. The aerosol-forming substrate may comprise one or more cellulose based strengthening agents.

[0010] There is also provided an aerosol-generating system comprising: an aerosol-generating device; and an aerosol-generating article comprising an aerosol-forming substrate, the aerosol-forming substrate comprising: one or more aerosol formers; hydroxypropylmethyl cellulose; and one or more cellulose based strengthening agents.

[0011] As used herein, the term "aerosol-generating article" refers to an article for producing an aerosol. An aerosol-generating article typically comprises an aerosol-forming substrate that is suitable and intended to be heated or combusted in order to release volatile compounds that can form an aerosol. A conventional cigarette is lit when a user applies a flame to one end of the cigarette and draws air through the other end. The localised heat provided by the flame and the oxygen in the air drawn through the cigarette causes the end of the cigarette to ignite, and the resulting combustion generates an inhalable smoke. By contrast, in "heated aerosol-generating articles", an aerosol is generated by heating an aerosol-forming substrate and not by combusting the aerosol-forming substrate. Known heated aerosol-generating articles include, for example, electrically heated aerosol-generating articles.

[0012] As used herein, the term "aerosol-forming substrate" refers to a substrate that is capable of producing upon heating volatile compounds, which can form an aerosol. The aerosol generated from aerosol-forming substrate may be visible to the human eye or invisible and may include vapours (for example, fine particles of substances, which are in a gaseous state, that are ordinarily liquid or solid at room temperature) as well as gases and liquid droplets of condensed vapours.

[0013] An aerosol-forming substrate that includes a combination of hydroxypropylmethyl cellulose and a cellulose based strengthening agent may have a number of advantages.

[0014] The inclusion of hydroxypropylmethyl cellulose in the aerosol-forming substrate may help in improving the manufacturing process of the aerosol-forming substrate. For example, hydroxypropylmethyl cellulose may reduce the overall viscosity of the slurry that is mixed when making the aerosol-forming substrate. A lower viscosity slurry may flow more easily compared to conventional slurries, and a lower viscosity slurry is easier to mix, transfer and handle during the manufacturing process.

[0015] The inclusion of a cellulose based strengthening agent in the aerosol-forming substrate may increase the tensile strength of the aerosol-forming substrate. An aerosol-forming substrate with a higher tensile strength may be less likely to deteriorate or break, for example during transit or during the manufacturing process.

[0016] Despite the above mentioned advantages, the present inventors found that an aerosol-forming substrate con-

taining hydroxypropylmethyl cellulose may have insufficient tensile strength. However, using a cellulose based strengthening agent to increase the tensile strength of the aerosol-forming substrate may overcome the reduction in tensile strength caused by the inclusion of hydroxypropylmethyl cellulose, whilst still providing the above mentioned processing advantages associated with hydroxypropylmethyl cellulose.

[0017] The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of greater than about 0.5 percent by weight. Advantageously, the present inventors have found that hydroxypropylmethyl cellulose may be an effective binder for an aerosol-forming substrate.

[0018] The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of greater than about 1 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of greater than about 5 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of greater than about 10 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of greater than about 15 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of greater than about 20 percent by weight.

[0019] The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of less than about 50 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of less than about 45 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of less than about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of less than about 35 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of less than about 30 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of less than about 25 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of less than about 20 percent by weight.

[0020] The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 50 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 45 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 20 percent by weight.

[0021] The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 1 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 10 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 15 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 20 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 25 percent by weight and about 40 percent by weight.

[0022] The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 45 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 1 percent by weight and about 45 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 1 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 10 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 10 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 15 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 15 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a hydroxypropylmethyl cellulose content of between about 20 percent by weight and about 25 percent by weight.

[0023] The hydroxypropylmethyl cellulose may be low viscosity hydroxypropylmethyl cellulose. For example, the hydroxypropylmethyl cellulose may have a viscosity of 0.05 Pa/s. In some examples the hydroxypropylmethyl cellulose may have a viscosity of 0.015 Pa/s. In some examples the hydroxypropylmethyl cellulose may have a viscosity of between 0.015 Pa/s and 0.05 Pa/s.

[0024] Advantageously, the present inventors have found that using low viscosity hydroxypropylmethyl cellulose may provide benefits during the manufacturing process. Use of low viscosity hydroxypropylmethyl cellulose may result in a low viscosity slurry being formed, which is easier to mix and transfer during manufacturing and processing.

[0025] The aerosol-forming substrate may have a cellulose based strengthening agent content of greater than about 0.5 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of greater than about 1 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of greater than about 5 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of greater than about 10 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of greater than about 15 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of greater than about 20 percent by weight.

[0026] The aerosol-forming substrate may have a cellulose based strengthening agent content of less than about 50 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of less than about 45 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of less than about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of less than about 35 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of less than about 30 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of less than about 25 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of less than about 20 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of less than about 15 percent by weight.

[0027] The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 50 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 45 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 15 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 0.5 percent by weight and about 5 percent by weight.

[0028] The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 1 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 10 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 15 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 20 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 25 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 30 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 35 percent by weight and about 40 percent by weight.

[0029] The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 1 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 10 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 10 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 15 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose based strengthening agent content of between about 15 percent by weight and about 20 percent by weight.

[0030] The one or more cellulose based strengthening agents may comprise cellulose fibres. Advantageously, the present inventors have found that cellulose fibres may be a cellulose based strengthening agent that is particularly effective at increasing the tensile strength of an aerosol-forming substrate.

[0031] The aerosol-forming substrate may have a cellulose fibres content of greater than about 0.5 percent by weight.

The aerosol-forming substrate may have a cellulose fibres content of greater than about 1 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of greater than about 5 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of greater than about 10 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of greater than about 15 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of greater than about 20 percent by weight.

[0032] The aerosol-forming substrate may have a cellulose fibres content of less than about 50 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of less than about 45 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of less than about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of less than about 35 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of less than about 30 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of less than about 25 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of less than about 20 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of less than about 15 percent by weight.

[0033] The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 50 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 45 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 15 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 0.5 percent by weight and about 5 percent by weight.

[0034] The aerosol-forming substrate may have a cellulose fibres content of between about 1 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 10 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 15 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 20 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 25 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 30 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 35 percent by weight and about 40 percent by weight.

[0035] The aerosol-forming substrate may have a cellulose fibres content of between about 1 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 10 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 10 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 15 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose fibres content of between about 15 percent by weight and about 20 percent by weight.

[0036] The one or more cellulose based strengthening agents may comprise microcrystalline cellulose. Advantageously, the present inventors have found that microcrystalline cellulose may be a cellulose based strengthening agent that is particularly effective at increasing the tensile strength of an aerosol-forming substrate.

[0037] The aerosol-forming substrate may have a microcrystalline cellulose content of greater than about 0.5 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of greater than about 1 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of greater than about 5 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of greater than about 10 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of greater than about 15 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of greater than about 20 percent by weight.

[0038] The aerosol-forming substrate may have a microcrystalline cellulose content of less than about 50 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of less than about 45 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of less than about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of less than about 35 percent by

weight. The aerosol-forming substrate may have a microcrystalline cellulose content of less than about 30 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of less than about 25 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of less than about 20 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of less than about 15 percent by weight.

[0039] The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 50 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 45 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 15 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 0.5 percent by weight and about 5 percent by weight.

[0040] The aerosol-forming substrate may have a microcrystalline cellulose content of between about 1 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 10 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 15 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 20 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 25 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 30 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 35 percent by weight and about 40 percent by weight.

[0041] The aerosol-forming substrate may have a microcrystalline cellulose content of between about 1 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 10 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 10 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 15 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a microcrystalline cellulose content of between about 15 percent by weight and about 20 percent by weight.

[0042] The one or more cellulose based strengthening agents may comprise cellulose powder. Advantageously, the present inventors have found that cellulose powder may be a cellulose based strengthening agent that is particularly effective at increasing the tensile strength of an aerosol-forming substrate.

[0043] The aerosol-forming substrate may have a cellulose powder content of greater than about 0.5 percent by weight. The aerosol-forming substrate may have a cellulose powder content of greater than about 1 percent by weight. The aerosol-forming substrate may have a cellulose powder content of greater than about 5 percent by weight. The aerosol-forming substrate may have a cellulose powder content of greater than about 10 percent by weight. The aerosol-forming substrate may have a cellulose powder content of greater than about 15 percent by weight. The aerosol-forming substrate may have a cellulose powder content of greater than about 20 percent by weight.

[0044] The aerosol-forming substrate may have a cellulose powder content of less than about 50 percent by weight. The aerosol-forming substrate may have a cellulose powder content of less than about 45 percent by weight. The aerosol-forming substrate may have a cellulose powder content of less than about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of less than about 35 percent by weight. The aerosol-forming substrate may have a cellulose powder content of less than about 30 percent by weight. The aerosol-forming substrate may have a cellulose powder content of less than about 25 percent by weight. The aerosol-forming substrate may have a cellulose powder content of less than about 20 percent by weight. The aerosol-forming substrate may have a cellulose powder content of less than about 15 percent by weight.

[0045] The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 50 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 45 percent by weight. The aerosol-forming substrate may have a cellulose powder

content of between about 0.5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 15 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 0.5 percent by weight and about 5 percent by weight.

[0046] The aerosol-forming substrate may have a cellulose powder content of between about 1 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 10 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 15 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 20 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 25 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 30 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 35 percent by weight and about 40 percent by weight.

[0047] The aerosol-forming substrate may have a cellulose powder content of between about 1 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 5 percent by weight and about 35 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 10 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 10 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 15 percent by weight and about 25 percent by weight. The aerosol-forming substrate may have a cellulose powder content of between about 15 percent by weight and about 20 percent by weight.

[0048] The aerosol-forming substrate may comprise a carboxymethyl cellulose. Advantageously, using a carboxymethyl cellulose may help to reduce crusting of the aerosol-forming substrate when used in an aerosol-generating article. In some examples, use of a carboxymethyl cellulose eliminates crusting. As explained below, crusting is the formation of a solid layer on a component of the aerosol-generating article. The present inventors have found that crusting may occur because a component of the aerosol-forming substrate may melt and then re-solidify around a component of the aerosol-generating article. Crusting can be a particular problem when an aerosol-forming substrate is used in an aerosol-generating article that contains a susceptor. If a crust is formed on the susceptor then the crusted susceptor becomes less effective at heating the aerosol-forming substrate, which may lead to reduced delivery of nicotine to a user and/or reduce formation of aerosol from the aerosol-forming substrate.

[0049] The carboxymethyl cellulose may comprise sodium carboxymethyl cellulose. Advantageously, the present inventors have found that sodium carboxymethyl cellulose is a carboxymethyl cellulose that may be particularly effective at preventing the above mentioned problem of crusting.

[0050] The aerosol-forming substrate may have a carboxymethyl cellulose content of greater than about 0.5 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of greater than about 1 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of greater than about 5 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of greater than about 10 percent by weight.

[0051] The aerosol-forming substrate may have a carboxymethyl cellulose content of less than about 20 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of less than about 15 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of less than about 10 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of less than about 8 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of less than about 5 percent by weight.

[0052] The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 0.5 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 0.5 percent by weight and about 15 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 0.5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 0.5 percent by weight and about 8 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 0.5 percent by weight and about 5 percent by weight.

[0053] The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 1 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 5 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 8 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 10 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 15 percent by weight and about 20 percent by weight.

[0054] The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 1 percent by weight and about 15 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 1 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxymethyl cellulose content of between about 5 percent by weight and about 8 percent by weight.

[0055] The aerosol-forming substrate may comprise nicotine.

[0056] The nicotine may comprise one or more nicotine salts. The one or more nicotine salts may be selected from the list consisting of nicotine lactate, nicotine citrate, nicotine pyruvate, nicotine bitartrate, nicotine benzoate, nicotine pectate, nicotine alginate, and nicotine salicylate.

[0057] The nicotine may comprise an extract of tobacco.

[0058] The aerosol-forming substrate may have a nicotine content of greater than about 0.5 percent by weight. The aerosol-forming substrate may have a nicotine content of greater than about 1 percent by weight. The aerosol-forming substrate may have a nicotine content of greater than about 2 percent by weight. The aerosol-forming substrate may have a nicotine content of greater than about 3 percent by weight. The aerosol-forming substrate may have a nicotine content of greater than about 5 percent by weight. The aerosol-forming substrate may have a nicotine content of greater than about 8 percent by weight.

[0059] The aerosol-forming substrate may have a nicotine content of less than about 10 percent by weight. The aerosol-forming substrate may have a nicotine content of less than about 8 percent by weight. The aerosol-forming substrate may have a nicotine content of less than about 5 percent by weight. The aerosol-forming substrate may have a nicotine content of less than about 3 percent by weight. The aerosol-forming substrate may have a nicotine content of less than about 2 percent by weight. The aerosol-forming substrate may have a nicotine content of less than about 1 percent by weight.

[0060] The aerosol-forming substrate may have a nicotine content of between about 0.5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 0.5 percent by weight and about 8 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 0.5 percent by weight and about 5 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 0.5 percent by weight and about 3 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 0.5 percent by weight and about 2 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 0.5 percent by weight and about 1 percent by weight.

[0061] The aerosol-forming substrate may have a nicotine content of between about 1 percent by weight and about 5 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 2 percent by weight and about 5 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 3 percent by weight and about 5 percent by weight.

[0062] The aerosol-forming substrate may have a nicotine content of between about 0.5 percent by weight and about 4 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 1 percent by weight and about 4 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 1 percent by weight and about 3 percent by weight. The aerosol-forming substrate may have a nicotine content of between about 1 percent by weight and about 2 percent by weight.

[0063] The aerosol-forming substrate may comprise one or more carboxylic acids. Advantageously, including one or more carboxylic acids in the aerosol-forming substrate may create a nicotine salt.

[0064] The one or more carboxylic acids comprise one or more of lactic acid and levulinic acid. Advantageously, the present inventors have found that lactic acid and levulnic acid are particularly good carboxylic acids for creating nicotine salts.

[0065] The aerosol-forming substrate may have a carboxylic acid content of greater than about 0.5 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of greater than about 1 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of greater than about 2 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of greater than about 3 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of greater than about 5 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of greater than about 8 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of greater than about 10 percent by weight. The aerosol-forming substrate may have a carboxylic acid

content of greater than about 15 percent by weight.

[0066] The aerosol-forming substrate may have a carboxylic acid content of less than about 20 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of less than about 15 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of less than about 10 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of less than about 8 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of less than about 5 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of less than about 3 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of less than about 2 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of less than about 1 percent by weight.

[0067] The aerosol-forming substrate may have a carboxylic acid content of between about 0.5 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 0.5 percent by weight and about 15 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 0.5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 0.5 percent by weight and about 8 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 0.5 percent by weight and about 5 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 0.5 percent by weight and about 3 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 0.5 percent by weight and about 2 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 0.5 percent by weight and about 1 percent by weight.

[0068] The aerosol-forming substrate may have a carboxylic acid content of between about 1 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 2 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 3 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 5 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 8 percent by weight and about 10 percent by weight.

[0069] The aerosol-forming substrate may have a carboxylic acid content of between about 1 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 1 percent by weight and about 15 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 1 percent by weight and about 10 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 1 percent by weight and about 8 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 2 percent by weight and about 5 percent by weight. The aerosol-forming substrate may have a carboxylic acid content of between about 3 percent by weight and about 5 percent by weight.

[0070] The aerosol-forming substrate may include one or more aerosol formers. Advantageously, including one or more aerosol formers in the aerosol-forming substrate improves the formation of aerosol.

[0071] The one or more aerosol formers may comprise glycerine. The one or more aerosol formers may comprise propylene glycol. The one or more aerosol formers may include a combination of glycerine and propylene glycol.

[0072] The aerosol-forming substrate may have an aerosol former content of greater than about 0.5 percent by weight. The aerosol-forming substrate may have an aerosol former content of greater than about 10 percent by weight. The aerosol-forming substrate may have an aerosol former content of greater than about 20 percent by weight. The aerosol-forming substrate may have an aerosol former content of greater than about 30 percent by weight. The aerosol-forming substrate may have an aerosol former content of greater than about 40 percent by weight. The aerosol-forming substrate may have an aerosol former content of greater than about 50 percent by weight. The aerosol-forming substrate may have an aerosol former content of greater than about 60 percent by weight.

[0073] The aerosol-forming substrate may have an aerosol former content of less than about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of less than about 70 percent by weight. The aerosol-forming substrate may have an aerosol former content of less than about 60 percent by weight.

[0074] The aerosol-forming substrate may have an aerosol former content of between about 0.5 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 0.5 percent by weight and about 70 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 0.5 percent by weight and about 60 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 0.5 percent by weight and about 50 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 0.5 percent by weight and about 40 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 0.5 percent by weight and about 30 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 0.5 percent by weight and about 20 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 0.5 percent by weight and about 10 percent by weight.

[0075] The aerosol-forming substrate may have an aerosol former content of between about 1 percent by weight and

about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 10 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 20 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 30 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 40 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 50 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 60 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 70 percent by weight and about 80 percent by weight.

[0076] The aerosol-forming substrate may have an aerosol former content of between about 20 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 30 percent by weight and about 80 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 30 percent by weight and about 70 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 40 percent by weight and about 70 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 40 percent by weight and about 60 percent by weight. The aerosol-forming substrate may have an aerosol former content of between about 50 percent by weight and about 60 percent by weight.

[0077] The ratio of the weight percent hydroxypropylmethyl cellulose content to the weight percent cellulose based strengthening agent content of the aerosol-forming substrate may be greater than or equal to about 1. The ratio of the weight percent hydroxypropylmethyl cellulose content to the weight percent cellulose based strengthening agent content of the aerosol-forming substrate may be greater than or equal to about 1.25. The ratio of the weight percent hydroxypropylmethyl cellulose content to the weight percent cellulose based strengthening agent content of the aerosol-forming substrate may be greater than or equal to about 1.5.

[0078] The ratio of the weight percent hydroxypropylmethyl cellulose content to the weight percent cellulose based strengthening agent content of the aerosol-forming substrate may be less than or equal to about 1. The ratio of the weight percent hydroxypropylmethyl cellulose content to the weight percent cellulose based strengthening agent content of the aerosol-forming substrate may be less than or equal to about 0.75. The ratio of the weight percent hydroxypropylmethyl cellulose content to the weight percent cellulose based strengthening agent content of the aerosol-forming substrate may be less than or equal to about 0.5.

[0079] The aerosol-generating article may include the aerosol-forming substrate.

[0080] The aerosol-generating article may include a hollow cellulose acetate tube.

[0081] The aerosol-generating article may include a spacer element.

[0082] The aerosol-generating article may include a mouthpiece filter.

[0083] The aerosol-forming substrate, the hollow cellulose acetate tube, the spacer element and the mouthpiece filter may be arranged sequentially. The aerosol-forming substrate, the hollow cellulose acetate tube, the spacer element and the mouthpiece filter may be arranged in a coaxial alignment.

[0084] The aerosol-generating article may include a cigarette paper.

[0085] The aerosol-forming substrate, the hollow cellulose acetate tube, the spacer element and the mouthpiece filter may be assembled by a cigarette paper.

[0086] The aerosol-generating article may have a mouth-end and a distal end 1013. In use, a user may insert the mouth-end into his or her mouth.

[0087] The aerosol-generating article may be suitable for use with an electrically-operated aerosol-generating device comprising a heater for heating the aerosol-generating substrate.

[0088] The aerosol-forming substrate may be provided in the form of a plug.

[0089] The aerosol-generating article may comprise a susceptor.

[0090] The susceptor may be a plurality of susceptor particles which may be deposited on or embedded within the aerosol-forming substrate. The susceptor particles may be immobilized by the aerosol-forming substrate and remain at an initial position. The susceptor particles may be homogeneously distributed in the aerosol- forming substrate. Due to the particulate nature of the susceptor, heat may be produced according to the distribution of the particles in the aerosol-forming substrate. Alternatively, the susceptor may be in the form of one or more sheets, strips, shreds or rods that may be placed next to or embedded in the aerosol-forming substrate. The aerosol-forming substrate may comprise one or more susceptor strips.

[0091] The aerosol-generating device may comprise a housing defining a device cavity configured to receive at least a portion of the aerosol-generating article.

[0092] The aerosol-generating device may comprise an atomiser configured to generate an aerosol from the aerosol-forming substrate.

[0093] The atomiser may be a thermal atomiser.

[0094] As used herein, the term "thermal atomiser" describes an atomiser that is configured to heat the aerosol-forming

substrate to generate an aerosol.

[0095] The aerosol-generating device may comprise any suitable type of thermal atomiser. For example, the thermal atomiser may comprise a heater. The thermal atomiser may comprise an electric heater. In one example, the thermal atomiser may comprise an electric heater comprising a heating element. The heating element may be a resistive heating element. In one example, the heating element may comprise a heater blade or pin adapted to be inserted into the aerosol-forming substrate so that the aerosol-forming substrate is heated from its inside. In another example, the heating element may partially or completely surround the aerosol-forming substrate and heat the aerosol-forming substrate circumferentially from its outside.

[0096] In another example, the thermal atomiser may comprise an inductive heating device. Inductive heating devices typically comprise an induction source that is configured to be coupled to a susceptor, which may be provided externally to the aerosol-forming substrate or internally within the aerosol-forming substrate. The induction source generates an alternating electromagnetic field that induces magnetization or eddy currents in the susceptor. The susceptor may be heated as a result of hysteresis losses or induced eddy currents which heat the susceptor through ohmic or resistive heating.

[0097] The aerosol-generating device may include a susceptor. The susceptor may be as described above in relation to the aerosol-generating article.

[0098] An aerosol-generating device comprising an inductive heating device may be configured to receive an aerosol-generating article having the aerosol-forming substrate and a susceptor in thermal proximity to the aerosol-forming substrate. Typically, the susceptor is in direct contact with the aerosol-forming substrate and heat is transferred from the susceptor to the aerosol-forming substrate primarily by conduction.

[0099] Examples of electrically operated aerosol-generating systems having inductive heating devices and aerosol-generating articles having susceptors are described in WO-A1-95/27411 and WO-A1-2015/177255.

[0100] The aerosol-generating device may comprise a battery and control electronics.

[0101] There is further provided an aerosol-generating system comprising an aerosol-forming substrate according to the invention and an atomiser configured to generate an aerosol from the aerosol-forming substrate.

[0102] The atomiser may be a thermal atomiser.

[0103] The aerosol-generating system may comprise any suitable type of thermal atomiser. For example, the thermal atomiser may comprise a heater. The thermal atomiser may comprise an electric heater. In one example, the thermal atomiser may comprise an electric heater comprising a heating element. The heating element may be a resistive heating element. In one example, the heating element may comprise a heater blade or pin adapted to be inserted into the aerosol-forming substrate so that the aerosol-forming substrate is heated from its inside. In another example, the heating element may partially or completely surround the aerosol-forming substrate and heat the aerosol-forming substrate circumferentially from its outside.

[0104] In another example, the thermal atomiser may comprise an inductive heating device. Inductive heating devices typically comprise an induction source that is configured to be coupled to a susceptor, which may be provided externally to the aerosol-forming substrate or internally within the aerosol-forming substrate. The induction source generates an alternating electromagnetic field that induces magnetization or eddy currents in the susceptor. The susceptor may be heated as a result of hysteresis losses or induced eddy currents which heat the susceptor through ohmic or resistive heating.

[0105] The aerosol-generating system may include a susceptor. The susceptor may be as described above in relation to the aerosol-generating article.

[0106] An aerosol-generating system comprising an inductive heating device may be configured to receive an aerosol-generating article having the aerosol-forming substrate and a susceptor in thermal proximity to the aerosol-forming substrate. Typically, the susceptor is in direct contact with the aerosol-forming substrate and heat is transferred from the susceptor to the aerosol-forming substrate primarily by conduction.

[0107] Examples of electrically operated aerosol-generating systems having inductive heating devices and aerosol-generating articles having susceptors are described in WO-A1-95/27411 and WO-A1-2015/177255.

[0108] The aerosol-generating system may comprise a battery and control electronics.

[0109] For the avoidance of doubt, features described above in relation to the aerosol-forming substrate may also relate, where appropriate, to the aerosol-generating article, the aerosol-generating device, and the aerosol-generating system. Similarly, features described above in relation to the aerosol-generating article may also relate, where appropriate, to the aerosol-generating device and to the aerosol-generating system, and *vice versa.*

[0110] It will be appreciated that any features described herein in relation to one embodiment of an aerosol-forming substrate, an aerosol-generating article, an aerosol-generating device, or an aerosol-generating system may also be applicable to other embodiments of aerosol-forming substrates, an aerosol-generating articles, an aerosol-generating devices, or aerosol-generating systems according to this disclosure. A feature described in relation to one embodiment may be equally applicable to another embodiment in accordance with this disclosure. It will also be appreciated that an aerosol generator according to this disclosure may be provided in an aerosol-generating device without a cartridge.

Accordingly, any of the features described herein with relation to a cartridge may be equally applicable to an aerosol-generating device.

[0111] The invention is defined in the claims. However, below there is provided a non-exhaustive list of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

[0112] EX1. An aerosol-forming substrate for use in an aerosol-generating system, the aerosol-forming substrate comprising:

one or more aerosol formers;
hydroxypropylmethyl cellulose; and
one or more cellulose based strengthening agents.

[0113] EX2. An aerosol-forming substrate according to example EX1, wherein the aerosol-forming substrate has a hydroxypropylmethyl cellulose content of greater than about 0.5 percent by weight.

[0114] EX3. An aerosol-forming substrate according to example EX2, wherein the aerosol-forming substrate has a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 50 percent by weight.

[0115] EX4. An aerosol-forming substrate according to example EX3, wherein the aerosol-forming substrate has a hydroxypropylmethyl cellulose content of between about 10 percent by weight and about 40 percent by weight.

[0116] EX5. An aerosol-forming substrate according to example EX4, wherein the aerosol-forming substrate has a hydroxypropylmethyl cellulose content of between about 15 percent by weight and about 30 percent by weight.

[0117] EX6. An aerosol-forming substrate according to example EX5, wherein the aerosol-forming substrate has a hydroxypropylmethyl cellulose content of between about 20 percent by weight and about 25 percent by weight.

[0118] EX7. An aerosol-forming substrate according to any one of examples EX1 to EX6, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of greater than about 0.5 percent by weight.

[0119] EX8. An aerosol-forming substrate according to example EX7, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of between about 0.5 percent by weight and about 50 percent by weight.

[0120] EX9. An aerosol-forming substrate according to example EX8, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of between about 0.5 percent by weight and about 40 percent by weight.

[0121] EX10. An aerosol-forming substrate according to example EX9, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of between about 5 percent by weight and about 30 percent by weight.

[0122] EX11. An aerosol-forming substrate according to example EX10, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of between about 10 percent by weight and about 20 percent by weight.

[0123] EX12. An aerosol-forming substrate according to example EX11, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of between about 15 percent by weight and about 20 percent by weight.

[0124] EX13. An aerosol-forming substrate according to one of examples EX1 to EX12, wherein the one or more cellulose based strengthening agents comprises cellulose fibres.

[0125] EX14. An aerosol-forming substrate according to example EX13, wherein the aerosol-forming substrate has a cellulose fibres content of greater than about 0.5 percent by weight.

[0126] EX15. An aerosol-forming substrate according to example EX14, wherein the aerosol-forming substrate has a cellulose fibres content of between about 0.5 percent by weight and about 50 percent by weight.

[0127] EX16. An aerosol-forming substrate according to example EX15, wherein the aerosol-forming substrate has a cellulose fibres content of between about 0.5 percent by weight and about 40 percent by weight.

[0128] EX17. An aerosol-forming substrate according to example EX16, wherein the aerosol-forming substrate has a cellulose fibres content of between about 5 percent by weight and about 30 percent by weight.

[0129] EX18. An aerosol-forming substrate according to example EX17, wherein the aerosol-forming substrate has a cellulose fibres content of between about 10 percent by weight and about 20 percent by weight.

[0130] EX19. An aerosol-forming substrate according to example EX18, wherein the aerosol-forming substrate has a cellulose fibres content of between about 15 percent by weight and about 20 percent by weight.

[0131] EX20. An aerosol-forming substrate according one of examples EX1 to EX19, wherein the one or more cellulose based strengthening agents comprises microcrystalline cellulose.

[0132] EX21. An aerosol-forming substrate according to example EX20, wherein the aerosol-forming substrate has a microcrystalline cellulose content of greater than about 0.5 percent by weight.

[0133] EX22. An aerosol-forming substrate according to example EX21, wherein the aerosol-forming substrate has a microcrystalline cellulose content of between about 0.5 percent by weight and about 50 percent by weight.

[0134] EX23. An aerosol-forming substrate according to example EX22, wherein the aerosol-forming substrate has a microcrystalline cellulose content of between about 0.5 percent by weight and about 40 percent by weight.

[0135] EX24. An aerosol-forming substrate according to example EX23, wherein the aerosol-forming substrate has a microcrystalline cellulose content of between about 5 percent by weight and about 30 percent by weight.

[0136] EX25. An aerosol-forming substrate according to example EX18, wherein the aerosol-forming substrate has a microcrystalline cellulose content of between about 10 percent by weight and about 20 percent by weight.

[0137] EX26. An aerosol-forming substrate according to example EX24, wherein the aerosol-forming substrate has a microcrystalline cellulose content of between about 15 percent by weight and about 20 percent by weight.

[0138] EX27. An aerosol-forming substrate according to any one of examples EX1 to EX26, wherein the one or more cellulose based strengthening agents comprises cellulose powder.

[0139] EX28. An aerosol-forming substrate according to example EX27, wherein the aerosol-forming substrate has a cellulose powder content of greater than about 0.5 percent by weight.

[0140] EX29. An aerosol-forming substrate according to example EX28, wherein the aerosol-forming substrate has a cellulose powder content of between about 0.5 percent by weight and about 50 percent by weight.

[0141] EX30. An aerosol-forming substrate according to example EX29, wherein the aerosol-forming substrate has a cellulose powder content of between about 0.5 percent by weight and about 40 percent by weight.

[0142] EX31. An aerosol-forming substrate according to example EX30, wherein the aerosol-forming substrate has a cellulose powder content of between about 5 percent by weight and about 30 percent by weight.

[0143] EX32. An aerosol-forming substrate according to example EX31, wherein the aerosol-forming substrate has a cellulose powder content of between about 10 percent by weight and about 20 percent by weight.

[0144] EX33. An aerosol-forming substrate according to example EX32, wherein the aerosol-forming substrate has a cellulose powder content of between about 15 percent by weight and about 20 percent by weight.

[0145] EX34. An aerosol-forming substrate according to any one of examples EX1 to EX33, wherein the aerosol-forming substrate comprises a carboxymethyl cellulose.

[0146] EX35. An aerosol-forming substrate according to example EX34, wherein the aerosol-forming substrate has a carboxymethyl cellulose content of greater than about 0.5 percent by weight.

[0147] EX36. An aerosol-forming substrate according to example EX35, wherein the aerosol-forming substrate has a carboxymethyl cellulose content of between about 0.5 percent by weight and about 20 percent by weight.

[0148] EX37. An aerosol-forming substrate according to example EX36, wherein the aerosol-forming substrate has a carboxymethyl cellulose content of between about 0.5 percent by weight and about 15 percent by weight.

[0149] EX38. An aerosol-forming substrate according to example EX37, wherein the aerosol-forming substrate has a carboxymethyl cellulose content of between about 5 percent by weight and about 10 percent by weight.

[0150] EX39. An aerosol-forming substrate according to example EX38, wherein the aerosol-forming substrate has a carboxymethyl cellulose content of between about 5 percent by weight and about 7 percent by weight.

[0151] EX40. An aerosol-forming substrate according to any one of examples EX28 to EX39, wherein the carboxymethyl cellulose comprises sodium carboxymethyl cellulose.

[0152] EX41. An aerosol-forming substrate according to any one of examples EX1 to EX40, wherein the aerosol-forming substrate comprises nicotine.

[0153] EX42. An aerosol-forming substrate according to example EX41, wherein the aerosol-forming substrate has a nicotine content of greater than about 0.5 percent by weight.

[0154] EX43. An aerosol-forming substrate according to example EX42, wherein the aerosol-forming substrate has a nicotine content of between about 0.5 percent by weight and about 5 percent by weight.

[0155] EX44. An aerosol-forming substrate according to any one of examples EX1 to EX43, wherein the aerosol-forming substrate comprises one or more carboxylic acids.

[0156] EX45. An aerosol-forming substrate according to example EX44, wherein the one or more carboxylic acids comprise one or more of lactic acid and levulinic acid.

[0157] EX46. An aerosol-generating article comprising the aerosol-forming substrate of any one of examples EX1 to EX45.

[0158] EX42. An aerosol-generating system comprising:

an aerosol-generating device; and
an aerosol-generating article comprising according to example EX46.

[0159] Specific embodiments will be further described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 illustrates an example of an aerosol-generating article containing the aerosol-forming substrate as described herein; and
Figure 2 illustrates an example of an aerosol-generating system comprising an aerosol-generating device and the aerosol-generating article shown in Figure 1.

[0160] Aerosol-generating systems for delivering an aerosol to a user typically comprise an atomiser configured to

generate an inhalable aerosol from an aerosol-forming substrate. Some known aerosol-generating systems comprise a thermal atomiser such as an electric heater or an inductive heating device. The thermal atomiser is configured to heat and vaporise the aerosol-forming substrate to generate an aerosol. Typical aerosol-forming substrates for use in aerosol-generating systems are nicotine formulations, which may be liquid nicotine formulations comprising an aerosol former such as glycerine and/or propylene glycol.

[0161] Some aerosol-forming substrates have a low tensile strength. This means that such aerosol-forming substrates may break apart or deteriorate before the aerosol-generating article is used by a user, which is undesirable. Some aerosol-forming substrates have a tendency to melt, which may result in a crust forming on a part of the aerosol-generating article. A crust being formed on a part of the aerosol-generating article may reduce the level of nicotine that is delivered to a user. A crust being formed on a part of the aerosol-generating article may reduce the volume of aerosol that is generated by the aerosol-generating system.

[0162] For example, as discussed above, in an aerosol-generating system that includes an inductive heating device, the aerosol-generating article may include a susceptor that can be heated by an induction source. The heat from the susceptor then transfers to the aerosol-forming substrate. Components of the aerosol-forming substrate may then vaporise to produce an aerosol. However, if the susceptor becomes coated in an aerosol-forming substrate crust then the crust may reduce heat transfer from the heated susceptor to the aerosol-forming substrate. The reduction in heat transfer from the heated susceptor to the aerosol-forming substrate may reduce the level of nicotine delivered to a user. The reduction in heat transfer from the heated susceptor to the aerosol-forming substrate may reduce the volume of aerosol that is generated by the aerosol-generating system.

[0163] It is therefore desirable to provide an aerosol-forming substrate that has an increased tensile strength. It is also desirable to provide an aerosol-forming substrate that has a reduced tendency to melt, which may lower the effect of crusting of the aerosol-forming substrate on a component of an aerosol-generating article.

[0164] Figure 1 illustrates an example of an aerosol-generating article 1000 containing an aerosol-forming substrate as described herein.

[0165] In the example of Figure 1, the aerosol-generating article 1000 includes four elements: the aerosol-forming substrate 1020, a hollow cellulose acetate tube 1030, a spacer element 1040, and a mouthpiece filter 1050. The four elements 1020, 1030, 1040, 1050 are arranged sequentially and in a coaxial alignment. The four elements 1020, 1030, 1040, 1050 are assembled by a cigarette paper 1060 to form the aerosol-generating article 1000.

[0166] In the example of Figure 1, the aerosol-generating article 1000 has a mouth-end 1012 and a distal end 1013. A user may insert the mouth-end 1012 into his or her mouth during use. The distal end 1013 is located at the opposite end of the aerosol-generating article 1000 to the mouth end 1012. The example of an aerosol-generating article 1000 illustrated in Figure 1 is particularly suitable for use with an electrically-operated aerosol-generating device comprising a heater for heating the aerosol-generating substrate.

[0167] In one example, when assembled, the aerosol-generating article 1000 is about 45 millimetres in length and has an outer diameter of about 7.2 millimetres and an inner diameter of about 6.9 millimetres.

[0168] In the example of Figure 1, the aerosol-forming substrate 1020 is provided in the form of a plug made by crimping a sheet of aerosol-forming substrate. A number of examples of aerosol-forming substrate 1020 are shown in Table 1 below. The sheet is gathered, crimped and wrapped in a filter paper (not shown) to form the plug.

[0169] An aerosol-generating article 1000 as illustrated in Figure 1 is designed to engage with an aerosol-generating device in order to be consumed. Such an aerosol-generating device includes means for heating the aerosol-forming substrate 1020 to a sufficient temperature to form an aerosol. Typically, the aerosol-generating device may comprise a heating element that surrounds the aerosol-generating article 1000 adjacent to the aerosol-forming substrate 1020, or a heating element that is inserted into the aerosol-forming substrate 1020.

[0170] Once engaged with an aerosol-generating device, a user draws on the mouth-end 1012 of the smoking article 1000 and the aerosol-forming substrate 1020 is heated to a temperature of about 375 degrees Celsius. At this temperature, volatile compounds are evolved from the aerosol-forming substrate 1020. These compounds condense to form an aerosol. The aerosol is drawn through the filter 1050 and into the user's mouth.

[0171] Figure 2 illustrates a portion of an electrically-operated aerosol-generating system 2000. The aerosol-generating system utilises a heating blade 2100 to heat an aerosol-generating substrate 1020 of an aerosol-generating article 1000. In the example of Figure 2, the heating blade 2100 is mounted within an aerosol article receiving chamber of an electrically-operated aerosol-generating device 2010. The aerosol-generating device 2010 defines a plurality of air holes 2050 for allowing air to flow to the aerosol-generating article 1000. Air flow is indicated by the arrows in Figure 2. The aerosol-generating device 2010 comprises a power supply and electronics, which are not illustrated in Figure 2. The aerosol-generating article 1000 of Figure 2 is as described in relation to Figure 1.

Examples

[0172] Example formulations of an aerosol-forming substrate according to the invention (Examples A, B, C, D and E)

are prepared having the compositions shown in Table 1.

Table 1

Example	A	B	C	D	E
Hydroxypropylmethyl Cellulose (% by weight)	22.39	12.50	26.67	26.67	23.71
Cellulose Fibres (% by weight)	16.79	31.25	6.67	6.67	0
Microcrystalline Cellulose (% by weight)	0	0	0	6.67	0
Cellulose Powder (% by weight)	0	0	0	0	17.79
Sodium Carboxymethyl Cellulose (% by weight)	5.60	6.25	0	0	5.93
Agar (% by weight)	0	0	6.67	6.67	0
Nicotine (% by weight)	1.40	0	0	0	1.48
Glycerine (% by weight)	50.37	50.00	60.00	53.33	47.43
Lactic Acid (% by weight)	3.45	0	0	0	3.66

[0173] The aerosol-forming substrates of Examples A, B, C, D and E are prepared by:

(1) mixing the components together with water using heat and agitation to form a slurry;
(2) casting a layer of the slurry onto a plane surface to form a film having a thickness of about 210 micrometres;
(3) leaving the film on the plane surface to solidify; and
(3) drying the film by heating the film to about 140 degrees Celsius for about 8 minutes.

[0174] The aerosol-forming substrates obtained after drying are solid. In other words, the aerosol-forming substrates each have a stable size and shape and do not flow. The term "stable" is used herein to indicate that the aerosol-forming substrates substantially maintain their shape and mass when exposed to a variety of environmental conditions. As such, aerosol-forming substrates substantially do not release or absorb water when exposed to standard temperature and pressure while varying the relative humidity from about 10 percent to about 60 percent.

[0175] This is particularly advantageous as it ensures that aerosol-forming substrates in accordance with the present invention do not release a liquid phase during storage or transportation, for example, from the manufacturing facility to a point of sale.

[0176] In use in an aerosol-generating device, as described above, the aerosol-forming substrates of Examples A, B, C, D and E are heated to a temperature of between about 375 degrees Celsius. The nicotine and glycerine contained in the film evaporate. The nicotine and glycerine condense to form an inhalable aerosol. The aerosol can then be inhaled by a user. The aerosol-forming substrates shrink slightly and their volumes are reduced. However, the film remains solid and maintains its film form. The aerosol-forming substrates appear to harden slightly and to take on a darker, brownish colour.

[0177] The aerosol-forming substrate of Example A includes a combination of hydroxypropylmethyl cellulose and a cellulose based strengthening agent. In Example A, the cellulose based strengthening agent is cellulose fibres. The aerosol-forming substrate of Example A also includes sodium carboxymethyl cellulose, nicotine, glycerine and a carboxylic acid. In Example A, the carboxylic acid is lactic acid.

[0178] The aerosol-forming substrate of Example B includes a combination of hydroxypropylmethyl cellulose and a cellulose based strengthening agent. In Example B, the cellulose based strengthening agent is cellulose fibres. The aerosol-forming substrate of Example B contains more cellulose fibres than the aerosol-forming substrate of Example A. The aerosol-forming substrate of Example B also includes sodium carboxymethyl cellulose and glycerine.

[0179] The aerosol-forming substrate of Example C includes a combination of hydroxypropylmethyl cellulose and a cellulose based strengthening agent. In Example C, the cellulose based strengthening agent is cellulose fibres. The aerosol-forming substrate of Example C contains fewer cellulose fibres than the aerosol-forming substrate of Example A. The aerosol-forming substrate of Example C includes agar rather than sodium carboxymethyl cellulose. The aerosol-forming substrate of Example C also includes glycerine.

[0180] The aerosol-forming substrate of Example D includes a combination of hydroxypropylmethyl cellulose and two cellulose based strengthening agents. In Example D, the cellulose based strengthening agents are cellulose fibres and microcrystalline cellulose. The aerosol-forming substrate of Example D contains fewer cellulose fibres than the aerosol-forming substrate of Example A. The aerosol-forming substrate of Example D includes agar rather than sodium carboxymethyl cellulose. The aerosol-forming substrate of Example D also includes glycerine.

[0181] The aerosol-forming substrate of Example E includes a combination of hydroxypropylmethyl cellulose and a cellulose based strengthening agent. In Example E, the cellulose based strengthening agent is cellulose powder. The aerosol-forming substrate of Example E also includes sodium carboxymethyl cellulose, nicotine, glycerine and a carboxylic acid. In Example E, the carboxylic acid is lactic acid.

[0182] The effect of the components of the above Examples A, B, C and D, including the effect of the cellulose based strengthening agents, will now be shown by comparison to an example of a comparative aerosol-forming substrate. The comparative aerosol-forming substrate includes 25.53 percent by weight hydroxypropylmethyl cellulose, 6.38 percent by weight agar, and 63.81 percent by weight glycerine.

[0183] Table 2 shows a comparison of tensile strength between the five example formulations of the aerosol-forming substrate (Examples A, B, C and D), and the comparative example.

[0184] The tensile strength of the example formulations and the comparative formulation is measured by using the conventional method of stretching a given size of a test specimen of each formulation at a constant rate of elongation until it ruptures. A tensile strength testing instrument is attached to the test specimen, which provides a measure of the fracture force when the formulation ruptures. The tensile strength of a test specimen is derived from the fracture force at rupture divided by the width of the specimen.

Table 2

Example	Comparative Example	A	B	C	D
Tensile Strength (N/m)	421	677	1580	830	1199

[0185] As shown in Table 2, the aerosol-forming substrate of Example A provides an increase in tensile strength of 256 N/m compared to the comparative example. This is a 61% increase in tensile strength.

[0186] The aerosol-forming substrate of Example B provides an increase in tensile strength of 1159 N/m compared to the comparative example. This is a 275% increase in tensile strength.

[0187] The aerosol-forming substrate of Example C provides an increase in tensile strength of 409 N/m compared to the comparative example. This is a 97% increase in tensile strength.

[0188] The aerosol-forming substrate of Example D provides an increase in tensile strength of 778 N/m compared to the comparative example. This is a 185% increase in tensile strength.

[0189] Accordingly, the aerosol-forming substrates of Examples A, B, C and D all show large increases in tensile strength compared to the comparative example. The present inventors have found that this increase in the tensile strength of the aerosol-forming substrate may provide a number of advantages, particularly relating to the subsequent processing steps of manufacturing an aerosol-generating article that contains the aerosol-forming substrate.

[0190] For example, after an aerosol-forming substrate is made, it is typically rolled onto a bobbin. An increase in the tensile strength of the aerosol-forming substrate may reduce breakage of the aerosol-forming substrate due to tension when it is transferred to the bobbin.

[0191] The subsequent manufacturing step usually involves unwinding the aerosol-forming substrate from the bobbin, and then crimping the aerosol-forming substrate using crimping rollers. An increase in the tensile strength of the aerosol-forming substrate may reduce breakage during the crimping process.

[0192] Reduced breakage of the aerosol-forming substrate during subsequent processing steps may reduce wastage of aerosol-forming substrate during the process of manufacturing an aerosol-generating article containing the aerosol-forming substrate. In addition, if the aerosol-forming substrate breaks during the processing steps then there may be loss of manufacturing time and so increased tensile strength of the aerosol-forming substrate may improve manufacturing time.

[0193] Although the aerosol-forming substrates of Examples C and D exhibit a high increase in tensile strength, Examples C and D may cause crusting on a part of an aerosol-generating article containing the aerosol-forming substrate because they contain agar. The present inventors believe that the agar melts when it is heated (for example by an aerosol-generating device). The melted agar can form agglomerate and form around the part of the aerosol-generating article. After the aerosol-generating article stops being heated, the melted agar may then cool and solidify as a crust. This is particularly a problem with an aerosol-generating article containing a susceptor because it has been found that crusting on the susceptor reduces heat transfer from the susceptor to the aerosol-forming substrate, which may reduce the level of nicotine and the volume of aerosol delivered to a user.

[0194] The aerosol-forming substrates of Examples A and B do not contain agar. Instead, the aerosol-forming substrates of Examples A and B contain sodium carboxymethyl cellulose. The present inventors have found that an aerosol-forming substrate containing a carboxymethyl cellulose instead of agar has reduced crusting. Indeed, in some examples, the present inventors have found that using a carboxymethyl cellulose instead of agar may completely eliminate the problem of crusting. Reducing and eliminating crusting, particularly crusting on a susceptor, may lead to an increased

level of nicotine being delivered to a user, and an increased volume of aerosol being generated from the aerosol-forming substrate.

Claims

1. An aerosol-forming substrate for use in an aerosol-generating system, the aerosol-forming substrate comprising:

   one or more aerosol formers, wherein the aerosol-forming substrate has an aerosol former content of greater than 30 percent by weight;
   hydroxypropylmethyl cellulose;
   one or more cellulose based strengthening agents, and
   carboxymethyl cellulose.

2. An aerosol-forming substrate according to claim 1, wherein the aerosol-forming substrate has a hydroxypropylmethyl cellulose content of between about 0.5 percent by weight and about 50 percent by weight.

3. An aerosol-forming substrate according to any preceding claim, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of greater than about 0.5 percent by weight.

4. An aerosol-forming substrate according to claim 3, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of between about 0.5 percent by weight and about 50 percent by weight.

5. An aerosol-forming substrate according to claim 4, wherein the aerosol-forming substrate has a cellulose based strengthening agent content of between about 0.5 percent by weight and about 40 percent by weight.

6. An aerosol-forming substrate according to any preceding claim, wherein the one or more cellulose based strengthening agents comprises cellulose fibres.

7. An aerosol-forming substrate according to claim 6, wherein the aerosol-forming substrate has a cellulose fibres content of between about 0.5 percent by weight and about 50 percent by weight.

8. An aerosol-forming substrate according to any preceding claim, wherein the one or more cellulose based strengthening agents comprises microcrystalline cellulose.

9. An aerosol-forming substrate according to claim 8, wherein the aerosol-forming substrate has a microcrystalline cellulose content of between about 0.5 percent by weight and about 50 percent by weight.

10. An aerosol-forming substrate according to any preceding claim, wherein the one or more cellulose based strengthening agents comprises cellulose powder.

11. An aerosol-forming substrate according to claim 10, wherein the aerosol-forming substrate has a cellulose powder content of between about 0.5 percent by weight and about 50 percent by weight.

12. An aerosol-forming substrate according to claim 1, wherein the aerosol-forming substrate has a carboxymethyl cellulose content of great than about 0.5 percent by weight.

13. An aerosol-forming substrate according to claim 1, wherein the aerosol-forming substrate has a carboxymethyl cellulose content of between about 0.5 percent by weight and about 20 percent by weight.

14. An aerosol-forming substrate according to any of claims 1, 12 or 13, wherein the carboxymethyl cellulose comprises sodium carboxymethyl cellulose.

15. An aerosol-generating article comprising the aerosol-forming substrate of any preceding claim.

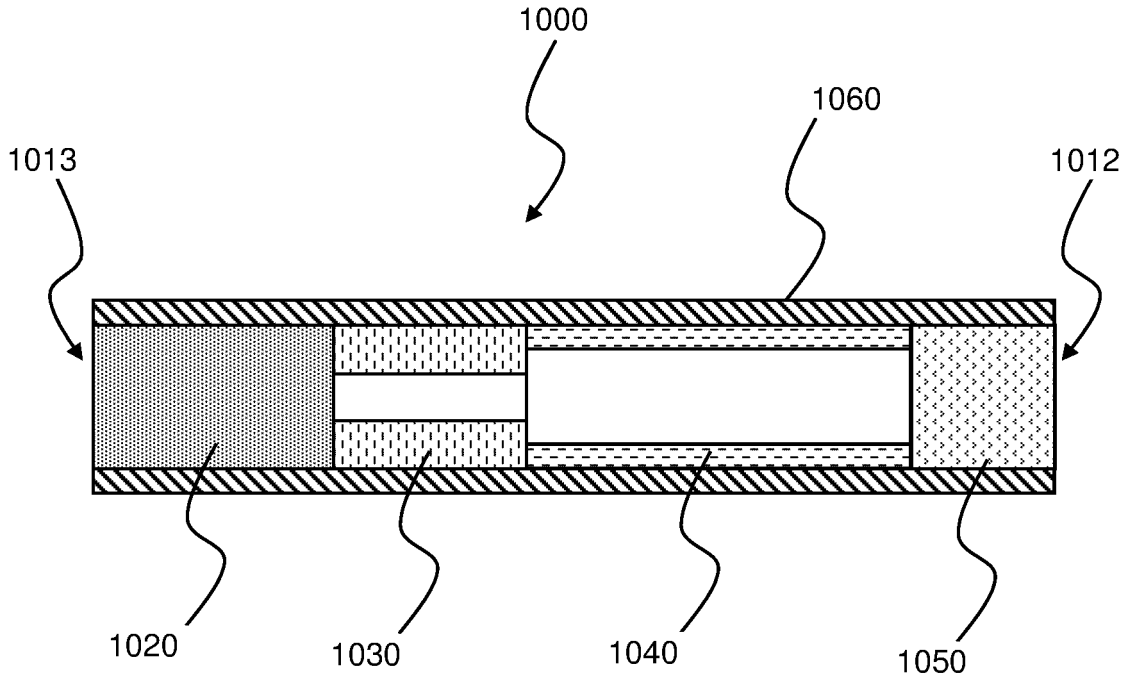

Figure 1

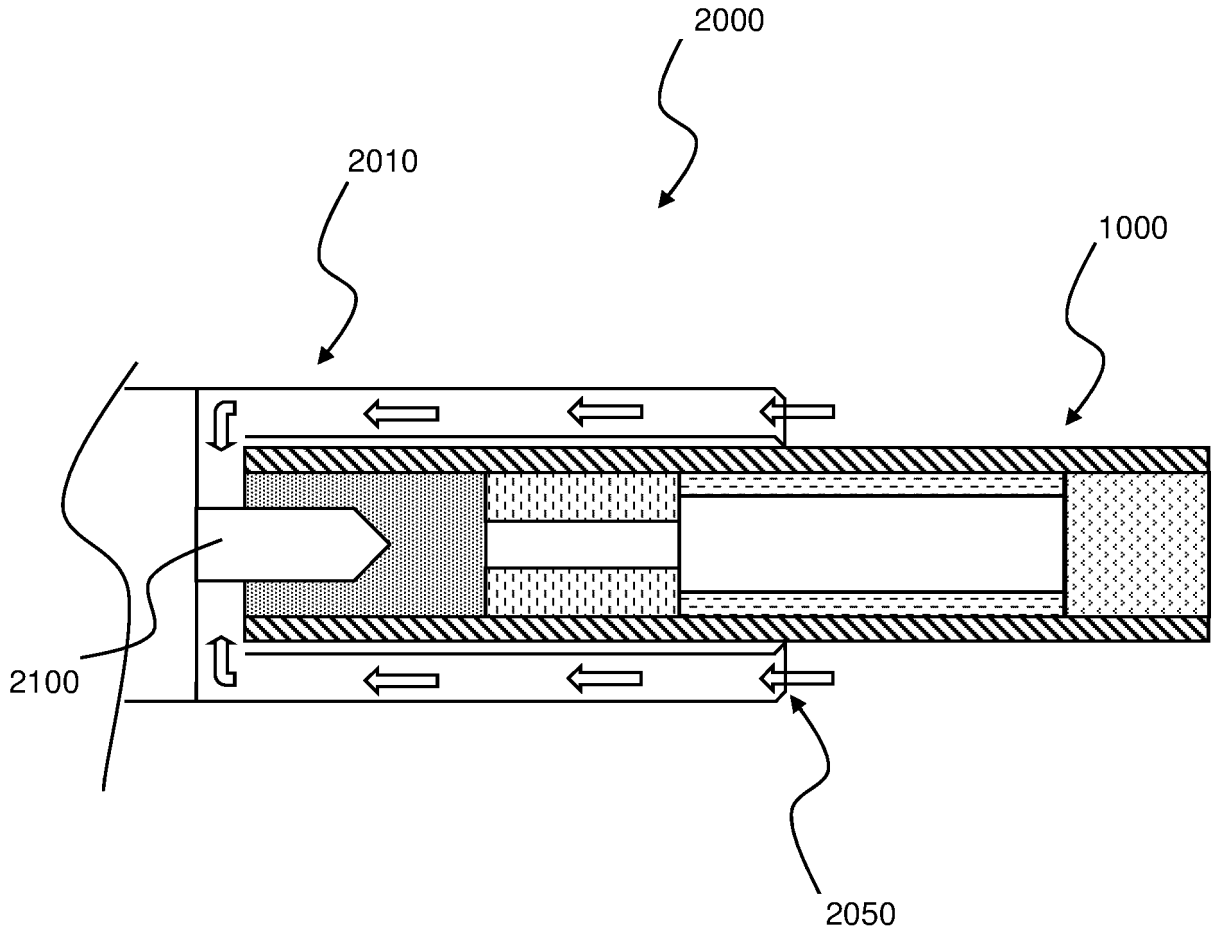

Figure 2

REFERENCES CITED IN THE DESCRIPTION

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- WO 2015177255 A1 **[0099] [0107]**