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(54) **Title:** IMPROVED AEROSOL-FORMING SUBSTRATE

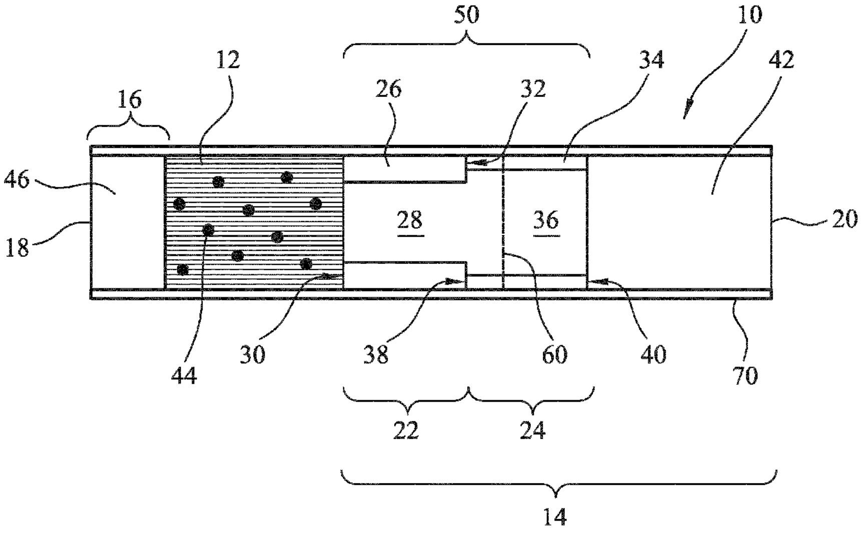

Figure 1

(57) **Abstract:** There is provided an aerosol-forming substrate comprising, on a dry weight basis: between 10 and 90 wt % carbon particles; between 7 and 60 wt % of an aerosol former; between 2 and 20 wt % of fibres; and between 2 and 10 wt % of a binder. Each of the carbon particles consists of one or more of graphite, expanded graphite, graphene, carbon nanotubes, charcoal, and diamond. There is also provided an aerosol-generating article comprising the aerosol-forming substrate and a method of forming the aerosol-forming substrate.

WO 2023/280994 A1

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IMPROVED AEROSOL-FORMING SUBSTRATE

The present disclosure relates to an aerosol-forming substrate. The present disclosure also relates to a method of making an aerosol-forming substrate, an aerosol-generating article, and an aerosol-generating system.

A typical aerosol-generating system comprises an aerosol-generating device and an aerosol-generating article comprising an aerosol-forming substrate. In use, the aerosol-generating device interacts with the aerosol-generating article to heat the aerosol-forming substrate and cause the aerosol-forming substrate to release volatile compounds. These compounds then cool to form an aerosol which is inhaled by a user.

Known aerosol-forming substrates typically have relatively low thermal conductivities. This may be undesirable, particularly in aerosol-generating systems in which a blade is inserted into the aerosol-forming substrate and heated in order to heat the aerosol-forming substrate. This is because the low thermal conductivity of the aerosol-forming substrate may lead to a relatively large temperature gradient in the aerosol-forming substrate during use. This may mean that portions of the aerosol-forming substrate which are located furthest from the blade do not reach a high temperature and so do not release as many volatile compounds as they would if the aerosol-forming substrate had a higher thermal conductivity. In other words, the low thermal conductivity of the aerosol-forming substrate may undesirably result in a low usage efficiency of the aerosol-forming substrate.

Further, known aerosol-forming substrates are typically not heatable to operating temperatures by induction. This means that, for inductive heating, a separate susceptor element is typically required. This can increase costs. In addition, this can lead to the same issues as discussed above. For example, where an inductively heated susceptor element is placed in a central position in the substrate, portions of the aerosol-forming substrate which are located furthest from the susceptor element may not reach a high temperature and therefore may not release many volatile compounds.

Attempts have been made to increase the thermal conductivity of aerosol-forming substrates. However, to date, these attempts have been inadequate in one or more respects.

It is an aim of the present invention to provide an improved aerosol-forming substrate, for example an aerosol-forming substrate having an increased thermal conductivity.

According to the present disclosure, there is provided an aerosol-forming substrate. The aerosol-forming substrate may comprise, on a dry weight basis, between 10 and 90 weight percent [wt %] thermally conductive particles. The aerosol-forming substrate may comprise, on a dry weight basis, between 7 and 60 wt % of an aerosol former. The aerosol-forming substrate may comprise, on a dry weight basis, between 2 and 20 wt % of fibres. The aerosol-forming substrate may comprise, on a dry weight basis, between 2 and 10 wt % of a binder. Each of the thermally conductive particles may consist of one or more of graphite, expanded graphite, graphene, carbon nanotubes, charcoal, and diamond.

Thus, according to a first aspect of the present disclosure, there is provided an aerosol-forming substrate comprising, on a dry weight basis: between 10 and 90 wt % thermally conductive particles; between 7 and 60 wt % of an aerosol former; between 2 and 20 wt % of fibres; and between 2 and 10 wt % of a binder, wherein each of the thermally conductive particles consists of one or more of graphite, expanded graphite, graphene, carbon nanotubes, charcoal, and diamond.

Where the term “thermally conductive particles” is used to refer to particles comprising carbon, for example particles comprising or consisting of one or more of graphite, expanded graphite, graphene, carbon nanotubes, charcoal, and diamond, the thermally conductive particles may be referred to as carbon particles or carbon-containing particles.

Advantageously, the thermally conductive particles may increase the thermal conductivity of the aerosol-forming substrate. The increased thermal conductivity of the substrate may provide a more even temperature distribution throughout the substrate during use. This may result in a greater proportion of the aerosol-forming substrate reaching a sufficiently high temperature to release volatile compounds, and thus a higher usage efficiency of the aerosol-forming substrate. Further, the increased thermal conductivity of the substrate may allow a heater, for example a heating blade configured to heat the substrate, to operate at a lower temperature and thus require less power. Further still, the increased thermal conductivity of the substrate may allow a heater to heat the substrate to a temperature in which volatile compounds are released in less time. Thus, the increased thermal conductivity may reduce the time required to form an inhalable aerosol for a user.

Advantageously, one or both of the fibres and the binder may increase a tensile strength of the aerosol-forming substrate. The increased tensile strength may allow the production of a sheet of the aerosol-forming substrate which does not easily tear. The increased tensile strength may allow the production of a sheet of the aerosol-forming substrate using existing production machinery.

The aerosol-forming substrate may have a thermal conductivity of at least 0.05, 0.1, 0.15, 0.2, 0.22, 0.3, 0.4, or 0.5 W/(mK) in at least one direction, or in all directions, at 25 degrees Celsius. This thermal conductivity may be measured when a moisture content of the substrate is between 0 and 20, or 5 and 15, for example around 10%. This thermal conductivity may be measured when the substrate comprises between 0 and 20, or 5 and 15, for example around 10 wt % water. The moisture or water content of the substrate may be measured using a titration method. The moisture or water content of the substrate may be measured using the Karl Fisher method.

Optionally, some or all of the thermally conductive particles comprise at least 10, 30, 50, 70, 90, 95, 98, or 99 wt % carbon.

Optionally, some or all of the thermally conductive particles are graphite particles. Optionally, some or all of the thermally conductive particles are expanded graphite particles.

Optionally, some or all of the thermally conductive particles are graphene particles. Optionally, some or all of the thermally conductive particles are carbon nanotubes or carbon nanotube particles. Optionally, some or all of the thermally conductive particles are charcoal particles. Optionally, some or all of the thermally conductive particles are diamond particles, for example artificial diamond particles. Advantageously, such materials may have relatively high thermal conductivities.

Expanded graphite may have a density less than 2, 1.8, 1.5, 1.2, 1, 0.8, or 0.5, 0.2, 0.1, 0.05, 0.02 grams per centimetre cubed (g / cm^3). Expanded graphite may have a density greater than 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 0.8, 1, 1.2, 1.5 or 1.8 grams per centimetre cubed (g / cm^3). Expanded graphite may have a density between 0.01 and 3, 0.01 and 2, 0.01 and 1.8, 0.01 and 1.5, 0.01 and 1.2, 0.01 and 1, 0.01 and 0.8, 0.01 and 0.5, 0.02 and 3, 0.02 and 2, 0.02 and 1.8, 0.02 and 1.5, 0.02 and 1.2, 0.02 and 1, 0.02 and 0.8, 0.02 and 0.5, 0.01 and 3, 0.05 and 2, 0.05 and 1.8, 0.05 and 1.5, 0.05 and 1.2, 0.05 and 1, 0.05 and 0.8, 0.05 and 0.5 g/cm^3, 0.1 and 3, 0.1 and 2, 0.1 and 1.8, 0.1 and 1.5, 0.1 and 1.2, 0.1 and 1, 0.1 and 0.8, 0.1 and 0.5, 0.2 and 3, 0.2 and 2, 0.2 and 1.8, 0.2 and 1.5, 0.2 and 1.2, 0.2 and 1, 0.2 and 0.8, 0.2 and 0.5, 0.5 and 3, 0.5 and 2, 0.5 and 1.8, 0.5 and 1.5, 0.5 and 1.2, 0.5 and 1, 0.5 and 0.8, 0.8 and 3, 0.8 and 2, 0.8 and 1.8, 0.8 and 1.5, 0.8 and 1.2, 0.8 and 1 grams per centimetre cubed (g / cm^3).

Optionally, according to aspects where each of the thermally conductive particles does not necessarily consist of one or more of graphite, expanded graphite, graphene, carbon nanotubes, charcoal, and diamond, some or all of the thermally conductive particles comprise a metal. Alternatively, or in addition, some or all of the thermally conductive particles comprise an alloy. Alternatively, or in addition, some or all of the thermally conductive particles comprise an intermetallic. Advantageously, such materials may have relatively high thermal conductivities.

Optionally, according to alternative aspects where each of the thermally conductive particles does not necessarily consist of one or more of graphite, expanded graphite, graphene, carbon nanotubes, charcoal, and diamond, some or all of the thermally conductive particles comprise one or more of silicon carbide, silver, copper, gold, aluminium nitride, aluminium, tungsten, and boron nitride. Optionally, some or all of the thermally conductive particles are silicon carbide particles. Optionally, some or all of the thermally conductive particles are silver particles. Optionally, some or all of the thermally conductive particles are copper particles. Optionally, some or all of the thermally conductive particles are gold particles. Optionally, some or all of the thermally conductive particles are aluminium nitride particles. Optionally, some or all of the thermally conductive particles are aluminium particles. Optionally, some or all of the thermally conductive particles are tungsten particles. Optionally, some or all of the thermally conductive particles are boron nitride particles. Advantageously, such materials may have relatively high thermal conductivities.

The thermally conductive particles may each have a “particle size”. The meaning of the term “particle size” and a method of measuring particle size is set out later.

The thermally conductive particles may be characterised by a particle size distribution. The particle size distribution may have number D10, D50 and D90 particle sizes. The number D10 particle size is defined such that 10% of the particles have a particles size less than or equal to the number D10 particle size. Similarly, the number D50 particle size is defined such that 50% of the particles have a particles size less than or equal to the number D50 particle size. Thus, the number D50 particle size may be referred to as a median particle size. The number D90 particle size is defined such that 90% of the particles have a particles size less than or equal to the number D90 particle size. Thus, if there were 1,000 particles in the distribution and the particles were order by ascending particle size, one would expect the number D10 particle size to be roughly equal to the particle size of the 100th particle, the number D50 particle size to be roughly equal to the particle size of the 500th particle, and the number D90 particle size to be roughly equal to the particle size of the 900th particle.

The particle size distribution may have volume D10, D50 and D90 particle sizes. The volume D10 particle size is defined such that 10% of the sum of the volumes of all of the particles is accounted for by the sum of the volumes of the particles having a particles size less than or equal to the volume D10 particle size. Similarly, the volume D50 particle size is defined such that 50% of the sum of the volumes of all of the particles is accounted for by the sum of the volumes of the particles having a particles size less than or equal to the volume D50 particle size. And the volume D90 particle size is defined such that 90% of the sum of the volumes of all of the particles is accounted for by the sum of the volumes of the particles having a particles size less than or equal to the volume D90 particle size.

Optionally, the thermally conductive particles have a particle size distribution having a number D10 particle size, wherein the number D10 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Optionally, the thermally conductive particles have a particle size distribution having a number D10 particle size, wherein the number D10 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

A compromise has to be made when deciding the sizes of the particle. Larger thermally conductive particles may advantageously increase the thermal conductivity of the aerosol-forming substrate more than smaller thermally conductive particles. However, larger thermal conductive particles may reduce the space available for aerosol-forming material in the substrate.

Optionally, the thermally conductive particles have a particle size distribution having a number D50 particle size, wherein the number D50 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Optionally, the thermally conductive particles have a particle size distribution having a number D50 particle size, wherein the number D50 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Optionally, the thermally conductive particles have a particle size distribution having a number D90 particle size, wherein the number D90 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Optionally, the thermally conductive particles have a particle size distribution having a number D90 particle size, wherein the number D90 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Optionally, the thermally conductive particles have a particle size distribution having a number D10 particle size and a number D90 particle size, wherein the number D90 particle size is no more than 50, 40, 30, 20, 10, or 5 times the number D10 particle size.

Optionally, the thermally conductive particles have a particle size distribution having a number D10 particle size and a number D90 particle size, wherein the number D90 particle size is at least 1.5, 2, 3, 5, 10, or 20 times the number D10 particle size.

A compromise must be made in relation to the particle size distribution. A tighter particle size distribution, for example characterised by a smaller ratio between the D90 and D10 particle sizes, may advantageously provide a more uniform thermal conductivity throughout the aerosol-forming substrate. This is because there will be less variation in particle size in different locations in the substrate. This may advantageously allow for more efficient usage of the aerosol-forming material throughout the aerosol-forming substrate. However, a tighter particle size distribution may disadvantageously be more difficult and expensive to achieve. The inventors have found that the particle size distributions described above may provide an optimal compromise between these two factors.

Optionally, the thermally conductive particles have a particle size distribution having a volume D10 particle size, wherein the volume D10 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Optionally, the thermally conductive particles have a particle size distribution having a volume D10 particle size, wherein the volume D10 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns

Optionally, the thermally conductive particles have a particle size distribution having a volume D50 particle size, wherein the volume D50 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Optionally, the thermally conductive particles have a particle size distribution having a volume D50 particle size, wherein the volume D50 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Optionally, the thermally conductive particles have a particle size distribution having a volume D90 particle size, wherein the volume D90 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Optionally, the thermally conductive particles have a particle size distribution having a volume D90 particle size, wherein the volume D90 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

It may be particularly preferably for the thermally conductive particles have a particle size distribution having a volume D10 particle size between 1 and 20 microns. Alternatively, or in addition, it may be particularly preferably for the thermally conductive particles have a particle size distribution having a volume D90 particle size between 50 and 300 microns, or between 50 and 200 microns.

Optionally, the thermally conductive particles have a particle size distribution having a volume D10 particle size and a volume D90 particle size, wherein the volume D90 particle size is no more than 50, 40, 30, 20, 10, or 5 times the volume D10 particle size.

Optionally, the thermally conductive particles have a particle size distribution having a volume D10 particle size and a volume D90 particle size, wherein the volume D90 particle size is at least 1.5, 2, 3, 5, 10, or 20 times the volume D10 particle size.

As explained above, a compromise must be made in relation to the particle size distribution, and the inventors have found that the particle size distributions above may provide an optimal compromise.

Optionally, each of the thermally conductive particles has a particle size of at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns. Optionally, each of the thermally conductive particles has a particle size of no more than 1,000, 500, 300, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns. It may be particularly preferable for each of the thermally conductive particles to have a particle size of at least 1 micron. Alternatively, or in addition, it may be particularly preferable for each of the thermally conductive particles to have a particle size of no more than 300 microns. Particles smaller than 1 micron may be difficult to handle during manufacturing. In addition, particles smaller than 1 micron may be more likely to pass through a filter in an aerosol-generating article comprising the aerosol-forming substrate. Particles greater than 300 microns may take up a rather large amount of space in the substrate which could be used for aerosol-forming material. Thus, it may be particularly advantageous for each of the thermally conductive particles to have a particle size of at least 1 micron, or a particle size of no more than 300 microns, or both.

Optionally, each of the thermally conductive particles has three mutually perpendicular dimensions, a largest dimension of the three dimensions being no more than 10, 8, 5, 3, or 2 times larger than a smallest dimension of the three dimensions. Optionally, each of the thermally conductive particles has three mutually perpendicular dimension, a largest dimension of the three dimensions being no more than 10, 8, 5, 3, or 2 times larger than a second largest dimension of the three dimensions. Optionally, each of the thermally conductive particles is substantially spherical. Advantageously, the orientation of substantially spherical particles may not affect the thermal conductivity of the substrate as much as the orientation of non-spherical particles. Thus, the use of more spherical particles may result in less variability between different substrates where the orientations of the particles is not controlled. In addition, substantially spherical particles may be more easy to characterise.

Optionally, the thermally conductive particles comprise at least 10, 20, 50, 100, 200, 500, or 1000 particles. Advantageously, a greater number of particles in the aerosol-forming substrate may allow the thermal conductivity of the substrate to be more uniform.

Optionally, the substrate comprises, on a dry weight basis, at least 20, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80 or 85 wt % of the thermally conductive particles. Optionally, the substrate comprises, on a dry weight basis, no more than 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, or 15 wt % of the thermally conductive particles. Optionally, the substrate comprises, on a dry weight basis, between 10 and 90, 20 and 90, 30 and 90, 40 and 90, 50 and 90, 60 and 90, 70 and 90, 80 and 90, 10 and 80, 20 and 80, 30 and 80, 40 and 80, 50 and 80, 60 and 80, 70 and 80, 10 and 70, 20 and 70, 30 and 70, 40 and 70, 50 and 70, 60 and 70, 10 and 60, 20 and 60, 30 and 60, 40 and 60, 50 and 60, 10 and 50, 20 and 50, 30 and 50, 40 and 50, 10 and 40, 20 and 40, 30 and 40, 10 and 30, 20 and 30, or 10 and 20 wt % of the thermally conductive particles. It may be particularly preferable for the substrate to comprise, on a dry weight basis, between 50 and 90, or more preferably between 60 and 90, or even more preferably between 65 and 85, wt % of the thermally conductive particles.

A comprise must be made in relation to the weight percent of thermally conductive particles in the substrate. Increasing the weight percent of particles in the aerosol-forming substrate may advantageously increase the thermal conductivity of the substrate. However, increasing the weight percent of particles in the aerosol-forming substrate may also reduce the available space for one or more of the aerosol former, binder, and fibres, so could result in a substrate which forms less aerosol, or which has less tensile strength.

Optionally, the substrate comprises, on a dry weight basis, at least 10, 15, 20, 25, 30, 35, 40, 45, 50, or 55 wt % of the aerosol former. Optionally, the substrate comprises, on a dry weight basis, no more than 55, 50, 45, 40, 35, 30, 25, 20, or 15 wt % of the aerosol former. Optionally, the substrate comprises, on a dry weight basis, between 7 and 60, 10 and 60, 20 and 60, 30 and 60, 40 and 60, 50 and 60, 7 and 50, 10 and 50, 20 and 50, 30 and 50, 40 and 50, 7 and 40, 10 and 40, 20 and 40, 30 and 40, 7 and 30, 10 and 30, 20 and 30, 7 and 20, 10 and 20, or 7 and 10 wt % of the aerosol former. It may be particularly preferable for the substrate to comprise, on a dry weight basis, between 15 and 25 wt % of the aerosol former.

Optionally, the aerosol-former comprises or consists of one or more of: polyhydric alcohols, such as propylene glycol, polyethylene glycol, triethylene glycol, 1, 3-butanediol and glycerine; esters of polyhydric alcohols, such as glycerol mono-, di- or tri-acetate; and aliphatic esters of mono-, di- or poly-carboxylic acids, such as dimethyl dodecanedioate and dimethyl tetradecanedioate. Optionally, the aerosol-forming substrate comprises one or both of glycerine and glycerol.

Optionally, the substrate comprises, on a dry weight basis, at least 2, 4, 6, 8, 10, 12, 14, 16 or 18 wt % of the fibres. Optionally, the substrate comprises, on a dry weight basis, no more than 20, 18, 16, 14, 12, 10, 8, 6, or 4 wt % of the fibres. Optionally, the substrate comprises, on a dry weight basis, between 4 and 20, 6 and 20, 8 and 20, 10 and 20, 12 and 20, 14 and 20, 16 and 20, 18 and 20, 2 and 18, 4 and 18, 6 and 18, 8 and 18, 10 and 18, 12 and 18, 14 and 18, 16 and 18, 2 and 16, 4 and 16, 6 and 16, 8 and 16, 10 and 16, 12 and 16, 14 and 16, 2 and 14, 4 and 14, 6 and 14, 8 and 14, 10 and 14, 12 and 14, 2 and 12, 4 and 12, 6 and 12, 8 and 12, 10 and 12, 2 and 10, 4 and 10, 6 and 10, 8 and 10, 2 and 8, 4 and 8, 6 and 8, 2 and 6, 4 and 6, or 2 and 4 wt % of the fibres. It may be particularly preferable for the substrate to comprise, on a dry weight basis, between 2 and 10 wt % of the fibres.

Optionally, the fibres are cellulose fibres. Advantageously, cellulose fibres are not overly costly and can increase the tensile strength of the substrate.

Optionally, each of the fibres has three mutually perpendicular dimensions, a largest dimension of the three dimensions being at least 1.5, 2, 3, 5, 10, or 20 times larger than a smallest dimension of the three dimensions. Optionally, each of the fibres has three mutually perpendicular dimensions, a largest dimension of the three dimensions being at least 1.5, 2, 3, 5, 10, or 20 times larger than a second largest dimension of the three dimensions.

Optionally, the substrate comprises, on a dry weight basis, at least 4, 6, or 8 wt % of the binder. Optionally, the substrate comprises, on a dry weight basis, no more than 8, 6, or 4 wt % of the binder. Optionally, the substrate comprises, on a dry weight basis, between 4 and 10, 6 and 10, 8 and 10, 2 and 8, 4 and 8, 6 and 8, 2 and 6, 4 and 6, 2 and 4 wt % of the binder. It may be particularly preferable for the substrate to comprise, on a dry weight basis, between 2 and 10 wt % of the binder.

Suitable binders are well-known in the art and include, but are not limited to, natural pectins, such as fruit, citrus or tobacco pectins; guar gums, such as hydroxyethyl guar and hydroxypropyl guar; locust bean gums, such as hydroxyethyl and hydroxypropyl locust bean gum; alginate; starches, such as modified or derivitized starches; celluloses, such as methyl, ethyl, ethylhydroxymethyl and carboxymethyl cellulose; tamarind gum; dextran; pullalon; konjac flour; xanthan gum and the like. It may be particularly preferable for the binder to be or comprise guar. It may be particularly preferable for the binder to comprise or consist of one or more of carboxymethyl cellulose or hydroxypropyl cellulose or a gum such as guar gum.

Optionally, the thermally conductive particles are substantially homogeneously distributed throughout the aerosol-forming substrate. Optionally, the aerosol former is substantially homogeneously distributed throughout the aerosol-forming substrate. Optionally, the fibres are substantially homogeneously distributed throughout the aerosol-forming substrate. Optionally, the binder is substantially homogeneously distributed throughout the aerosol-forming substrate. Advantageously, a homogenous distribution of components of the substrate may result in the substrate have more spatially uniform properties. For example, substantially homogeneously distributed thermally conductive particles may result in the substrate having a substantially uniform thermal conductivity. As another example, substantially homogeneously distributed binder or fibres may result in the substrate having a substantially uniform tensile strength.

Optionally, the substrate comprises nicotine. Optionally, the substrate comprises, on a dry weight basis, at least 0.01, 1, 2, 3, or 4 wt % nicotine. Optionally, the substrate comprises, on a dry weight basis, no more than 5, 4, 3, 2, or 1 wt % nicotine. Optionally, the substrate comprises, on a dry weight basis, between 0.01 and 5, 1 and 5, 2 and 5, 3 and 5, 4 and 5, 0.01 and 4, 1 and 4, 2 and 4, 3 and 4, 0.01 and 3, 1 and 3, 2 and 3, 0.01 and 2, 1 and 2, 0.01 and 1 wt % nicotine. It may be particularly preferable for the substrate to comprise, on a dry weight basis, between 0.5 and 4 wt % nicotine.

Optionally, the nicotine is substantially homogeneously distributed throughout the aerosol-forming substrate.

Optionally, the substrate comprises an acid. Optionally, the substrate comprises, on a dry weight basis, at least 0.01, 1, 2, 3, or 4 wt % of the acid. Optionally, the substrate comprises, on a dry weight basis, no more than 5, 4, 3, 2 or 1 wt % of the acid. Optionally, the substrate comprises, on a dry weight basis, between 0.01 and 5, 1 and 5, 2 and 5, 3 and 5, 4 and 5, 0.01 and 4, 1 and 4, 2 and 4, 3 and 4, 0.01 and 3, 1 and 3, 2 and 3, 0.01 and 2, 1 and 2, 0.01 and 1 wt % of the acid. It may be particularly preferable for the substrate to comprise, on a dry weight basis, between 0.5 and 5 wt % of acid.

Optionally, the acid comprises or consists of one or more of fumaric acid, lactic acid, benzoic acid, and levulinic acid.

Optionally, the acid is substantially homogeneously distributed throughout the aerosol-forming substrate.

Optionally, the substrate comprises at least one botanical. Optionally, the substrate comprises, on a dry weight basis, at least 0.01, 1, 2, 5, 10, or 15 wt % of the at least one botanical. Optionally, the substrate comprises, on a dry weight basis, no more than 20, 15, 10, 5, 2 or 1 wt % of the at least one botanical. Optionally, the substrate comprises, on a dry weight basis, between 0.01 and 20, 1 and 20, 2 and 20, 5 and 20, 10 and 20, 15 and 20, 0.01 and 15, 1 and 15, 2 and 15, 5 and 15, 10 and 15, 0.01 and 10, 1 and 10, 2 and 10, 5 and 10, 0.01 and 5, 1 and 5, 2 and 5, 0.01 and 2, 1 and 2, 0.01 and 1 wt % of the at least one botanical. It may be particularly preferable for the substrate to comprise, on a dry weight basis, between 1 and 15 wt % of the at least one botanical.

Optionally, the at least one botanical comprises or consists of one or both of clove and rosmarinus.

Optionally, the at least one botanical is substantially homogeneously distributed throughout the aerosol-forming substrate.

Optionally, the substrate comprises at least one flavourant. Optionally, the substrate comprises, on a dry weight basis, at least 0.1, 1, 2, or 5 wt % of the at least one flavourant.

Optionally, the substrate comprises, on a dry weight basis, no more than 10, 5, 2 or 1 wt % of the at least one flavourant. Optionally, the substrate comprises, on a dry weight basis, between 0.1 and 10, 1 and 10, 2 and 10, 5 and 10, 0.1 and 5, 1 and 5, 2 and 5, 0.1 and 2, 1 and 2, 0.1 and 1 wt % of the at least one flavourant. It may be particularly preferable for the substrate to comprise, on a dry weight basis, between 0.1 and 5 wt % of the at least one flavourant.

Optionally, the at least one flavourant is present as a coating, for example a coating on one or more other components of the aerosol-forming substrate. Alternatively, or in addition, the at least one flavourant is substantially homogeneously distributed throughout the aerosol-forming substrate.

Optionally, the aerosol-forming substrate comprises at least one organic material such as tobacco. Optionally, the at least one organic material comprises one or more of herb leaf, tobacco leaf, fragments of tobacco ribs, reconstituted tobacco, homogenised tobacco, extruded tobacco and expanded tobacco. Optionally, the at least one organic material is substantially homogeneously distributed throughout the aerosol-forming substrate.

The substrate may comprise, on a dry weight basis, less than 10, 5, 3, 2, or 1 wt % tobacco. Optionally, the aerosol-forming substrate is a tobacco-free aerosol-forming substrate.

The aerosol-forming substrate may be in the form of a rod. As such, there may be provided a rod of aerosol-forming substrate.

A susceptor element may be located within the rod of aerosol-forming substrate. The susceptor element may be an elongate susceptor element. The susceptor element may extend longitudinally within the rod of aerosol-forming substrate. The rod may be substantially cylindrical, for example right cylindrical, in shape. The susceptor element may be positioned in a radially central position within the rod of aerosol-forming substrate. The susceptor element may extend along a central, longitudinal axis of the rod of aerosol-forming substrate. The susceptor element may extend all the way to a downstream end of the rod of aerosol-forming substrate. The susceptor element may extend all the way to an upstream end of the rod of aerosol-forming substrate. The susceptor element may have substantially the same length as the rod of aerosol-forming substrate. The susceptor element may extend from the upstream end to the downstream end of the rod of aerosol-forming substrate. The susceptor element may be in the form of a pin, rod, strip or blade. The susceptor element may have a length of between 5 and 15, 6 and 12, or 8 and 10 millimetres. The susceptor element may have a width of between 1 and 5 millimetres. The susceptor element may have a thickness of between 0.01 and 2, 0.5 and 2, or 0.5 and 1 millimetres.

Alternatively, there may be no susceptor materials present in the aerosol-forming substrate or in the rod of aerosol-forming substrate.

Optionally, some or each of the thermally conductive particles may be inductively heatable, for example to a temperature of at least 100, 150, or 200 degrees Celsius. Optionally, some or each of the thermally conductive particles comprise or consist of one or more susceptor materials.

Advantageously, this may allow the thermally conductive particles to be inductively heated. The thermally conductive particles may comprise or be the only susceptor material(s) present in the aerosol-forming substrate or in the rod of aerosol-forming substrate. That is, there may be no susceptor elements present in the aerosol-forming substrate or in the rod of aerosol-forming substrate except for the thermally conductive or carbon particles.

Suitable susceptor materials include but are not limited to: carbon, carbon-based materials, graphene, graphite, expanded graphite, molybdenum, silicon carbide, stainless steels, niobium, aluminium, nickel, nickel-containing compounds, titanium, and composites of metallic materials. Suitable susceptor materials may comprise a ferromagnetic material, for example, ferritic iron, a ferromagnetic alloy, such as ferromagnetic steel or stainless steel, ferromagnetic particles, and ferrite. A suitable susceptor material may be, or comprise, aluminium. A susceptor material preferably comprises more than 5 percent, preferably more than 20 percent, more preferably more than 50 percent or more than 90 percent of ferromagnetic or paramagnetic materials. Preferred susceptor materials may comprise a metal, metal alloy or carbon.

Particularly preferred susceptor materials may be, or comprise, carbon, carbon-based materials, graphene, graphite, or expanded graphite. Advantageously, such materials have relatively high thermal conductivities, relatively low densities, and may be inductively heated.

Optionally, the aerosol-forming substrate has a thermal conductivity of greater than 0.05, 0.1, 0.15, 0.2, 0.3, 0.4, 0.5, 0.75, 1, 1.25, 1.5, 2, 5, 10, 20, 50, 100, 200, or 500 W/(mK) in at least one direction at 25 degrees Celsius.

Optionally, the aerosol-forming substrate has a density of no more than 1500, 1450, 1400, 1350, 1300, 1250, 1200, 1100, 1050, 1000, 950, 900, 850, 800, 850, 800, 750, 700, 650, or 600 kg/m^3. Optionally, the aerosol-forming substrate has a density of between 600 and 1400, 800 and 1200, or 900 and 1100 kg/m^3. Advantageously, reducing a density of the substrate may reduce transportation costs of the substrate.

Optionally, the aerosol-forming substrate has a moisture content of between 1 and 20, or 3 and 15 wt %. This moisture content may be measured after 48 hours equilibration at 50 % relative humidity at 20 degrees Celsius. Optionally, the aerosol-forming substrate comprises between 1 and 20, or 3 and 15 wt % water. The moisture or water content of the substrate may be measured using a titration method. The moisture or water content of the substrate may be measured using the Karl Fisher method.

Optionally, the aerosol-forming substrate comprises, or is in the form of, one or more of: cut-filler, powder particles, granules, pellets, shreds, spaghettis, strips, threads, ribbons, or sheets. Optionally, the aerosol-forming substrate comprises, or is in the form of, one or more sheets or strips.

Optionally, the aerosol-forming substrate comprises, or is in the form of, one or more sheets, for example gathered sheets. Optionally, the aerosol-forming substrate comprises, or is in the form of, a plurality of strips.

Optionally, the or each sheet or strip has a thickness of at least 5, 10, 20, 50, 100, 150, or 200 microns. Optionally, the or each sheet or strip has a thickness of no more than 2000, 1000, 500, 400, 300, or 250 microns. Optionally, the or each sheet or strip has a thickness of between 100 and 350, or 150 and 300 microns.

Optionally, the or each sheet or strip has a width of at least 100, 200, 500, or 1000 microns. Optionally, the or each sheet or strip has a width of no more than 2000, 1000, 500, 400, 300, 250, or 200 microns. Optionally, the or each sheet or strip has a width of between 100 and 2000, or 500 and 1000, or 600 and 1000 microns.

Optionally, the or each sheet or strip has a length of at least 100, 200, 500, 1000, 2000, or 3000 microns. Optionally, the or each sheet or strip has a length of no more than 6000, 5000, 3000, 2000, 1000, 500, or 200 microns. Optionally, the or each sheet or strip has a length of between 100 and 6000, or 500 and 5000, or 1000 and 4000 microns.

Optionally, the or each sheet or strip has a grammage of at least 20, 50, or 100 g/m^2. Optionally, the or each sheet or strip has a grammage of no more than 300 g/m^2. Optionally, the or each sheet or strip has a grammage of between 20 and 300, 50 and 250, or 100 and 250 g/m^2.

Optionally, the or each sheet or strip has a density of at least 0.1, 0.2, 0.3, or 0.5 g/m^3. Optionally, the or each sheet or strip has a density of no more than 2, 1.5, 1.2, or 1 g/m^3. Optionally, the or each sheet or strip has a density of between 0.1 and 2, 0.2 and 2, 0.3 and 2, 0.3 and 1.5, or 0.3 and 1.2 g/m^3.

Where the substrate comprises one or more gathered sheets, the or each gathered sheet may have a width of at least about 1, 2, 5, 10, 25, 50, or 100 mm.

According to the present disclosure, there is also provided a combined aerosol-forming substrate. The combined aerosol-forming substrate may comprise a first material and a second material, the first material being comprised in the combined aerosol-forming substrate as a first plurality of discrete elements and the second material being comprised in the combined aerosol-forming substrate as a second plurality of discrete elements. The first material may comprise an aerosol former .The first material may have a first thermal conductivity. The second material may have a second thermal conductivity that is greater than the first thermal conductivity.

Thus, according to a second aspect of the present disclosure, there is provided a combined aerosol-forming substrate comprising:

a first material and a second material, the first material being comprised in the combined aerosol-forming substrate as a first plurality of discrete elements and the second material being comprised in the combined aerosol-forming substrate as a second plurality of discrete elements,

in which the first material comprises an aerosol former and has a first thermal conductivity,

in which the second material has a second thermal conductivity that is greater than the first thermal conductivity.

Advantageously, the second material may boost the thermal conductivity of the substrate. As explained previously in relation to the first aspect, this may provide one or more of the following advantages: a smaller temperature gradient is present in the substrate during use, the usage efficiency of the substrate is increased, a heater of an aerosol-generating device is able to operate at a lower temperature, and a time taken to produce an aerosol is reduced.

The first material may be described as having a different material composition to the second material. Optionally, the second material comprises, or is, an aerosol-forming substrate as described above, for example the aerosol-forming substrate of the first aspect.

Optionally, the second thermal conductivity is at least 5% greater than the first thermal conductivity, for example at least 7, 10, 12, 15, 30, 50, 100, 200, or 500% greater. Optionally, the thermal conductivity of the second material is at least 10% greater than the thermal conductivity of the first material, for example at least 12, 15, 20, 30, 50, 100, 200, or 500% greater.

Optionally, the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements, are elongated elements, each having a length dimension that is greater than a width dimension and a thickness dimension.

Optionally, the elongated elements are in the form of strips, shreds, threads, or ribbons.

Optionally, the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements, are formed by a casting process, for example by a casting process followed by a cutting process.

Optionally, the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements, are formed by an extrusion process.

Optionally, at least a portion of the first plurality of discrete elements, or at least a portion of the second plurality of discrete elements, or at least a portion of both the first and second plurality of discrete elements, are crimped elements. For example, each crimped element may have one or more kinks or directional changes defined in a length dimension of the crimped element.

Optionally, one or both of the first material and the second material is comprised in the combined aerosol-forming substrate in the form of cut-filler.

Optionally, the discrete elements of the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements have an average thickness of between 5 microns and 2000 microns, for example between 50 microns and 500 microns, for example between 150 microns and 300 microns.

Optionally, the discrete elements of the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements have an average width of between 100 microns and 2000 microns, for example between 500 microns and 1500 microns, for example between 600 microns and 1000 microns.

Optionally, the discrete elements of the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements have an average length of between 100 microns and 60 millimetres, for example between 500 microns and 30 millimetres microns, for example between 1000 microns and 10000 microns.

Advantageously, the thicknesses, widths and lengths set out above have been found to facilitate the production of a suitable quantity of an aerosol with desirable properties upon heating by a heating element of an aerosol-generating device.

Optionally, the second material comprises thermally conductive particles. Optionally, the second material comprises at least 1, 2, 5, 10, 20, 30, 40, 50, 60, 70 or 80 wt% thermally conductive particles. Optionally, the second material comprises no more than 90, 80, 70, 60, 50, 40, 30, 20, 10, or 5 wt% thermally conductive particles. Optionally, the second material comprises, on a dry weight basis, between 1 and 90, 2 and 90, 5 and 90, 10 and 90, 20 and 90, 30 and 90, 40 and 90, 50 and 90, 60 and 90, 70 and 90, 80 and 90, 10 and 80, 20 and 80, 30 and 80, 40 and 80, 50 and 80, 60 and 80, 70 and 80, 10 and 70, 20 and 70, 30 and 70, 40 and 70, 50 and 70, 60 and 70, 10 and 60, 20 and 60, 30 and 60, 40 and 60, 50 and 60, 10 and 50, 20 and 50, 30 and 50, 40 and 50, 10 and 40, 20 and 40, 30 and 40, 10 and 30, 20 and 30, or 10 and 20 wt % of the thermally conductive particles.

Optionally, the second material comprises thermally conductive particles formed from a thermally conductive material selected from the list consisting of carbon, graphite, expanded graphite, graphene, and metal. Optionally, the second material is a thermally conductive material selected from the list consisting of carbon, graphite, expanded graphite, graphene, and metal, for example in which each discrete element of the second material is a strip of metal foil or carbon foil, for example copper foil, or aluminium foil, or stainless steel foil, or graphite foil. Advantageously, such materials have relatively high thermal conductivities.

Optionally, the first material has a thermal conductivity of less than 10, 5, 2, 1, 0.5 or 0.2W/(mK) in at least one direction at 25 degrees Celsius. Optionally, the second material has a thermal conductivity of greater than 0.1, 0.22, 0.3, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 1500, or 1700 W/(mK) in at least one direction at 25 degrees Celsius.

Optionally, the first material is configured to generate an aerosol on heating, for example on heating to a temperature of between 120 degrees Celsius and 395 degrees Celsius, and the second material is not configured to generate an aerosol on heating, for example on heating to a temperature of between 120 degrees Celsius and 350 degrees Celsius. Optionally, both the first material and the second material are configured to generate an aerosol on heating, for example on heating to a temperature of between 120 degrees Celsius and 395 degrees Celsius.

Optionally, the first material comprises tobacco, for example in which the first material is formed from homogenised tobacco. Optionally, the first material comprises tobacco and an aerosol-former, and is configured to generate an aerosol when heated to a temperature of between 120 degrees Celsius and 395 degrees Celsius. Optionally, the first material is a homogenised tobacco material, and further comprises one or both of fibres and a binder.

Optionally, the second material comprises an aerosol-former and thermally conductive particles constituting between 3 wt % and 90 wt % of the second material on a dry weight basis, the second material being configured to generate an aerosol when heated to a temperature of between 120 degrees Celsius and 395 degrees Celsius. Optionally, the second material comprises tobacco and an aerosol-former and conductive particles constituting between 3 wt % and 90 wt % of the second material on a dry weight basis, the second material being configured to generate an aerosol when heated to a temperature of between 120 degrees Celsius and 395 degrees Celsius. Optionally, the second material is a thermally conductive homogenised tobacco material, and further comprises fibres and a binder.

Optionally, the second material does not comprise tobacco, for example in which the second material is a thermally conductive tobacco-free material, and further comprises fibres and a binder.

Optionally, the discrete elements of the first material and the discrete elements of the second material are formed separately and mixed together in a predetermined ratio to form the combined aerosol-forming substrate.

Optionally, the ratio of the first material to second material in the combined aerosol-forming substrate is between 1:10 and 10:1, for example between 1:5 and 8:1, for example between 1:1 and 5:1.

Optionally, the second material comprises, on a dry weight basis: between 40 and 80 wt % of particulate carbon material; between 10 and 40 wt % of an aerosol former; between 4 and 20 wt % of fibres; and between 2 and 10 wt % of a binder, wherein the particulate carbon material consists of one or more of graphite, expanded graphite, graphene, carbon nanotubes, and charcoal.

Optionally, the first material comprises, on a dry weight basis: between 40 and 80 wt % of particulate carbon material; between 10 and 40 wt % of an aerosol former; between 4 and 20 wt % of fibres; and between 2 and 10 wt % of a binder, wherein the particulate carbon material consists of one or more of graphite, expanded graphite, graphene, carbon nanotubes, and charcoal, the first material having a lower thermal conductivity than the second material.

Optionally, the particulate carbon material consists of graphite.

Optionally, the second material and the first material are homogeneously distributed within the combined aerosol-forming substrate.

According to the present disclosure, there is provided a method of forming a combined aerosol-forming substrate, for example a combined aerosol-forming substrate as described above, such as the combined aerosol-forming substrate of the second aspect. The method may comprise steps of forming a first plurality of discrete elements from a first material. The method may comprise forming a second plurality of discrete elements from a second material. The method may comprise combining the first plurality of discrete elements with the second plurality of discrete elements, for example to form the combined aerosol-forming substrate. The second material may have a greater thermal conductivity than the first material.

Thus, according to a third aspect of the present disclosure, there is provided a method of forming a combined aerosol-forming substrate, for example a combined aerosol-forming substrate as described above, such as the combined aerosol-forming substrate of the second aspect, comprising steps of forming a first plurality of discrete elements from a first material; forming a second plurality of discrete elements from a second material, and combining the first plurality of discrete elements with the second plurality of discrete elements to form the combined aerosol-forming substrate, in which the second material has a greater thermal conductivity than the first material

Optionally, the method comprises steps of providing a first plurality of discrete elements from a first material; providing a second plurality of discrete elements from a second material, and combining the first plurality of discrete elements with the second plurality of discrete elements to form the combined aerosol-forming substrate, in which the second material has a greater thermal conductivity than the first material.

Optionally, the first plurality of discrete elements are formed by cutting a sheet of the first material into strips, and in which the second plurality of discrete elements are formed by cutting a sheet of the second material into strips.

Optionally, the first plurality of discrete elements and the second plurality of discrete elements are cut to be substantially the same size.

Optionally, the step of forming at least one of the first plurality of discrete elements and the second plurality of discrete elements involves a step of crimping, for example such that the first plurality of discrete elements, the second plurality of discrete elements, or both the first and second plurality of discrete elements are crimped elements.

Optionally, the method comprises the steps of forming the first material, forming the second material, or forming both the first and the second material.

Optionally, the combined aerosol-forming substrate is a combined aerosol-forming substrate according to the second aspect.

According to a fourth aspect of the present disclosure, there is also provided an aerosol-generating article.

The article may comprise an aerosol-forming substrate as described above, for example the aerosol-forming substrate according to the first aspect.

The article may comprise a combined aerosol-forming substrate as described above, for example the combined aerosol-forming substrate according to the second aspect.

The article may be manufactured by any method described above.

Optionally, the article is in the form of a rod and comprises a plurality of components, including the aerosol-forming substrate or the combined aerosol-forming substrate, assembled within a wrapper or casing.

Optionally, the aerosol-generating article comprises a front plug. Optionally, the aerosol-generating article comprises a first hollow tube, for example a first hollow acetate tube. Optionally, the aerosol-generating article comprises a second hollow tube, for example a second hollow acetate tube. Optionally, the second hollow tube comprises one or more ventilation holes. Optionally, the aerosol-generating article comprises a mouth plug filter. Optionally, the aerosol-generating article comprises wrapper, for example a paper wrapper.

Optionally, the front plug is arranged a most upstream end of the article. Optionally, the aerosol-forming substrate is arranged downstream of the front plug. Optionally, the first hollow tube is arranged downstream of the aerosol-forming substrate. Optionally, the second hollow tube is arranged downstream of the first hollow tube. Optionally, the mouth plug filter is arranged downstream of one or both of the first hollow tube and the second hollow tube. Optionally, the mouth plug filter is arranged at a most downstream end of the article. Optionally, the most downstream end of the article, which may be referred to as a mouth end of the article, may be configured for insertion into a mouth of a user. A user may be able to inhale on, for example directly on, the mouth end of the article.

Optionally, the front plug, the aerosol-forming substrate, one or both of the first hollow tube and the second hollow tube, and the mouth plug filter are circumscribed by a wrapper, for example a paper wrapper.

Optionally, the front plug has a length of between 2 and 10, 3 and 8, or 4 and 6 mm, for example around 5 mm. Optionally, the aerosol-forming substrate has a length of between 5 and 20, 8 and 15, or 10 and 15 mm, for example around 12 mm. Optionally, the first hollow tube has a length of between 2 and 20, 5 and 15, or 5 and 10 mm, for example around 8 mm. Optionally, the second hollow tube has a length of between 2 and 20, 5 and 15, or 5 and 10 mm, for example around 8 mm. Optionally, the mouth plug filter has a length of between 5 and 20, 8 and 15, or 10 and 15 mm, for example around 12 mm. The lengths of one or more of the front plug, the aerosol-forming substrate, the first hollow tube, the second hollow tube, and the mouth plug filter may extend in a longitudinal direction.

One or more of the front plug, the aerosol-forming substrate, the first hollow tube, the second hollow tube, and the mouth plug filter may be substantially cylindrical, for example right cylindrical, in shape.

According to a fourth aspect of the present disclosure, there is provided an aerosol-generating system.

The system may comprise an aerosol-generating article and an electrical aerosol-generating device. The article may be an article as described above, for example an article according to the third aspect.

Optionally, the electrical aerosol-generating device is configured to resistively heat the aerosol-generating article in use.

Optionally, the electrical aerosol-generating device is configured to inductively heat the aerosol-generating article, for example the aerosol forming substrate of the aerosol-generating article, in use.

According to the present disclosure, there is provided a method of forming an aerosol-forming substrate, for example a substrate as described above such as the substrate according to the first aspect. The method may comprise forming a slurry comprising one or more or all of the thermally conductive particles, the aerosol former, the fibres, and the binder. The method may comprise casting and drying the slurry to form the aerosol-forming substrate or a precursor for forming into the aerosol-forming substrate.

Thus, according to a fifth aspect of the present disclosure, there is provided a method of forming an aerosol-forming substrate, for example a substrate as described above such as the substrate according to the first aspect. The method comprises

forming a slurry comprising the thermally conductive particles, the aerosol former, the fibres, and the binder; and

casting and drying the slurry to form the aerosol-forming substrate or a precursor for forming into the aerosol-forming substrate.

Optionally, the slurry comprises water. Optionally, the slurry comprises between 20 and 90, 30 and 90, 40 and 90, 40 and 85, 50 and 80, 60 and 80, or 60 and 75 wt % water.

Optionally, the slurry comprises an acid. Optionally, the acid comprises or consists of one or more of fumaric acid, lactic acid, benzoic acid, and levulinic acid.

Optionally, the slurry comprises nicotine.

Optionally, forming the slurry comprises forming a first mixture. The first mixture may comprise the aerosol former. The first mixture may comprise the fibres. The first mixture may comprise water. The first mixture may comprise the acid. The first mixture may comprise the nicotine. Forming the slurring may comprise forming a second mixture. The second mixture may comprise the thermally conductive particles. The second mixture may comprise the binder. Forming the slurry may comprise adding the second mixture to the first mixture to form a combined mixture.

Thus, forming the slurry may comprise:

forming a first mixture comprising the aerosol former, the fibres, water, optionally, the acid, and optionally, the nicotine;

forming a second mixture comprising the thermally conductive particles and the binder;

and adding the second mixture to the first mixture to form a combined mixture.

The combined mixture may subsequently be formed into the slurry, for example by mixing.

Optionally, forming the first mixture comprises providing the aerosol former or a solution comprising the aerosol former and the nicotine.

Optionally, forming the first mixture comprises adding the acid to the aerosol former or the solution comprising the aerosol former and the nicotine to form a first pre-mixture.

Optionally, forming the first mixture comprises adding the water to the aerosol former or the solution comprising the aerosol former and the nicotine, or to the first pre-mixture, to form a second pre-mixture.

Optionally, forming the first mixture comprises adding the fibres to the second pre-mixture.

Optionally, forming the second mixture comprises mixing the thermally conductive particles and the binder.

Optionally, the method, for example the step of forming the slurry, comprises a first mixing of the combined mixture. Optionally, the first mixing occurs under a first pressure of no more than 500, 400, 300, 250, or 200 mbar. Optionally, the first mixing occurs for between 1 and 10, 2 and 8, or 3 and 6 minutes, for example for around 4 minutes.

Optionally, the method, for example the step of forming the slurry, comprises, after the first mixing, a second mixing. Optionally, the second mixing occurs under a second pressure which is less than the first pressure. Optionally, the second pressure is no more than 500, 400, 300, 200, 150, or 100 mbar. Optionally, the second mixing occurs for between 5 and 120, 5 and 80, 5 and 40, or 10 and 30 seconds, for example around 20 seconds.

Optionally, casting the slurry comprises casting the slurry onto a flat support, for example a steel flat support.

Optionally, after casting the slurry and before drying the slurry, the method comprises setting a thickness of the slurry, for example setting a thickness of the slurry to between 100 and 1200, 200 and 1000, 300 and 900, 500 and 700 microns, for example around 600 microns.

Optionally, drying the slurry comprises providing a flow of a gas such as air over or past the slurry. Optionally, the flow of gas is heated. Optionally, the flow of gas is heated to a temperature of between 100 and 160, or 120 and 140 degrees Celsius. Optionally, the flow of gas is provided for between 1 and 10 or 2 and 5 minutes. Optionally, drying the slurry comprises drying the slurry until the slurry has a moisture content of between 1 and 20, 2 and 15, 2 and 10, or 3 and 7 wt %.

Optionally, drying the slurry forms the precursor for forming into the aerosol-forming substrate, the precursor being a sheet of aerosol-forming material. Optionally, the method comprises cutting the sheet of aerosol-forming material.

As would be understood by the skilled person having read this disclosure, the features described herein in relation to one aspect may be applicable to any other aspect. For example, features described in relation to the combined aerosol-forming substrate of the second aspect, or in relation to the first second material of the combined aerosol-forming substrate of the second aspect, may be applicable to the aerosol-forming substrate of the first aspect, and *vice versa*.

As used herein, the term “aerosol-forming substrate” may refer to a substrate capable of releasing an aerosol or volatile compounds that can form an aerosol. Such volatile compounds may be released by heating the aerosol-forming substrate. An aerosol-forming substrate may comprise an aerosol-forming material. An aerosol-forming substrate may be adsorbed, coated, impregnated or otherwise loaded onto a carrier or support. An aerosol-forming substrate may conveniently be part of an aerosol-generating article or smoking article.

As used herein, the term “thermally conductive particles” may refer to particles having a thermal conductivity greater than 0.3, preferably 0.5, or more preferably 1 W/(mK) in at least one direction at 25 degrees Celsius, for example in all directions at 25 degrees Celsius. The particles may exhibit anisotropic or isotropic thermal conductivity.

As used herein, the term “expanded graphite” may refer to a graphite-based material, or a material having a graphite-like structure. Expanded graphite may have carbon layers (similar to graphite, for example) with spacing between the carbon layers greater than the spacing found between carbon layers in regular graphite. Expanded graphite may have carbon layers with elements or compounds intercalated into spaces between the carbon layers.

As used herein, the term “particle size” may refer to a single dimension and may be used to characterise the size of a given particle. The dimension may be the diameter of a spherical particle occupying the same volume as the given particle. All particle sizes and particle size distributions herein can be obtained using a standard laser diffraction technique. Particle sizes and particle size distributions as stated herein may be obtained using a commercially available sensor, for example a Sympatec HELOS laser diffraction sensor.

As used herein, where not otherwise specified, the term “density” may be used to refer to true density. Thus, where not otherwise specified, the density of a powder or plurality of particles may refer to the true density of the powder or plurality of particles (rather than the bulk density of the powder or plurality of particles, which can vary greatly depending on how the powder or plurality of particles are handled). The measurement of true density can be done using a number of standard methods, these methods often being based on Archimedes’ principle. The most widely used method, when used to measure the true density of a powder, entails the powder being placed inside a container (a pycnometer) of known volume, and weighed. The pycnometer is then filled with a fluid of known density, in which the powder is not soluble. The volume of the powder is determined by the difference between the volume as shown by the pycnometer, and the volume of liquid added (i.e. the volume of air displaced).

As used herein, the term “aerosol-generating article” may refer to an article able to generate, or release, an aerosol, for example when heated.

As used herein, the term “longitudinal” may refer to a direction extending between a downstream or proximal end and an upstream or distal end of a component such as an aerosol-forming substrate or aerosol-generating article.

As used herein, the term “transverse” may refer to a direction perpendicular to the longitudinal direction.

As used herein, the term “aerosol-generating device” may refer to a device for use with an aerosol-generating article to enable the generation, or release, of an aerosol.

As used herein, the term “gathered sheet” may refer to a sheet of an aerosol-forming substrate or aerosol-generating article that is convoluted, folded, or otherwise compressed or constricted substantially transversely to a longitudinal axis of the aerosol-forming substrate, or aerosol-generating article.

As used herein, the term “sheet” may refer to a generally planar, laminar element having a width and a length which are substantially greater than, for example at least 2, 3, 5, 10, 20 or 50 times, its thickness.

As used herein, the term “strip” may refer to a generally planar, laminar element having a width and a length which are substantially greater than its thickness. The width of a strip may be greater than its thickness, for example at least 2, 3, 5 or 10 times its thickness. The length of a strip may be greater than its width, for example at least 2, 3, 5 or 10 times its width.

As used herein, the term “aerosol former” may refer to any suitable known compound or mixture of compounds that, in use, facilitates formation of an aerosol. The aerosol may be a dense and stable aerosol. The aerosol may be substantially resistant to thermal degradation at the operating temperature of the aerosol-forming substrate or aerosol-generating article.

As used herein, the term “aerosol-cooling element” may refer to a component of an aerosol-generating article located downstream of the aerosol-forming substrate such that, in use, an aerosol formed by the substrate or by volatile compounds released from the aerosol-forming substrate passes through and is cooled by the aerosol-cooling element before being inhaled by a user.

As used herein, the term “rod” may refer to a generally cylindrical, for example right cylindrical, element of substantially circular, oval or elliptical cross-section.

As used herein, the term “crimped” may refer to a sheet having one or more ridges or corrugations. The ridges or corrugations may be substantially parallel. When present in a component of an aerosol-generating article, the ridges or corrugations may extend in a longitudinal direction with respect to the aerosol-generating article.

As used herein, the term “ventilation level” may refer to a volume ratio between the airflow admitted into an aerosol-generating article via the ventilation zone (ventilation airflow) and the sum of the aerosol airflow and the ventilation airflow. The greater the ventilation level, the higher the dilution of the aerosol flow delivered to the consumer.

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.

Example Ex1. An aerosol-forming substrate comprising, on a dry weight basis:

between 10 and 90 wt % thermally conductive particles;

between 7 and 60 wt % of an aerosol former;

between 2 and 20 wt % of fibres; and

between 2 and 10 wt % of a binder,

wherein each of the thermally conductive particles consists of one or more of graphite, expanded graphite, graphene, carbon nanotubes, charcoal, and diamond.

Example Ex 2. An aerosol-forming substrate according to any preceding example, wherein each thermally conductive particle of the thermally conductive particles has a thermal conductivity of at least 0.3, 0.5, 1, 2, 5, or 10 W/(mK) in at least one direction at 25 degrees Celsius.

Example Ex 3. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles comprise carbon, for example at least 10, 30, 50, 70, 90, 95, 98, or 99 wt % carbon.

Example Ex 4. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles are graphite particles, or some or all of the thermally conductive particles are expanded graphite particles, or some of the thermally conductive particles are graphite particles and some of the thermally conductive particles are expanded graphite particles.

Example Ex 5. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles are diamond particles, for example artificial diamond particles.

Example Ex 6. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles are graphene particles.

Example Ex 7. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles are carbon nanotubes.

Example Ex 8. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles are charcoal particles.

Example Ex 9. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles comprise a metal.

Example Ex 10. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles comprise one or both of copper and aluminium.

Example Ex 11. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles comprise an alloy.

Example Ex 12. An aerosol-forming substrate according to any preceding example, wherein some or all of the thermally conductive particles comprise an intermetallic.

Example Ex 13. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a number D10 particle size, wherein the number D10 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Example Ex 14. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a number D10 particle size, wherein the number D10 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Example Ex 15. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a number D50 particle size, wherein the number D50 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Example Ex 16. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a number D50 particle size, wherein the number D50 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Example Ex 17. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a number D90 particle size, wherein the number D90 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Example Ex 18. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a number D90 particle size, wherein the number D90 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Example Ex 19. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a volume D10 particle size, wherein the volume D10 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Example Ex 20. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a volume D10 particle size, wherein the volume D10 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns

Example Ex 21. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a volume D50 particle size, wherein the volume D50 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Example Ex 22. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a volume D50 particle size, wherein the volume D50 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Example Ex 23. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a volume D90 particle size, wherein the volume D90 particle size is at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Example Ex 24. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a volume D90 particle size, wherein the volume D90 particle size is no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Example Ex 25. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution having a number D10 particle size, a number D90 particle size, a volume D10 particle size, and a volume D90 particle size, wherein:

the number D90 particle size is no more than 50, 40, 30, 20, 10, or 5 times the number D10 particle size,

or the volume D10 particle size is no more than 50, 40, 30, 20, 10, or 5 times the volume D10 particle size,

or both the number D90 particle size is no more than 50, 40, 30, 20, 10, or 5 times the number D10 particle size and the volume D10 particle size is no more than 50, 40, 30, 20, 10, or 5 times the volume D10 particle size.

Example Ex 26. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution and one or both of a number D10 particle size and a volume D10 particle size is between 1 and 20 microns.

Example Ex 27. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles have a particle size distribution, wherein one or both of a number D90 particle size and a volume D90 particle size is between 50 and 300 microns or between 50 and 200 microns.

Example Ex 28. An aerosol-forming substrate according to any preceding example, wherein each of the thermally conductive particles has a particle size of at least 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, or 500 microns.

Example Ex 29. An aerosol-forming substrate according to any preceding example, wherein each of the thermally conductive particles has a particle size of no more than 1,000, 500, 200, 100, 50, 20, 10, 5, 2, 1, 0.5, or 0.2 microns.

Example Ex 30. An aerosol-forming substrate according to any preceding example, wherein each of the thermally conductive particles has three mutually perpendicular dimensions, a largest dimension of the three dimensions being no more than 10, 8, 5, 3, or 2 times larger than one or both of a smallest dimension of the three dimensions and a second largest dimension of the three dimensions.

Example Ex 31. An aerosol-forming substrate according to any preceding example, wherein each of the thermally conductive particles is substantially spherical.

Example Ex 32. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles comprise at least 10, 20, 50, 100, 200, 500, or 1000 particles.

Example Ex 33. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, at least 20, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80 or 85 wt % of the thermally conductive particles.

Example Ex 34. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, no more than 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, or 15 wt % of the thermally conductive particles.

Example Ex 35. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, between 10 and 90, 20 and 90, 30 and 90, 40 and 90, 50 and 90, 60 and 90, 70 and 90, 80 and 90, 10 and 80, 20 and 80, 30 and 80, 40 and 80, 50 and 80, 60 and 80, 70 and 80, 10 and 70, 20 and 70, 30 and 70, 40 and 70, 50 and 70, 60 and 70, 10 and 60, 20 and 60, 30 and 60, 40 and 60, 50 and 60, 10 and 50, 20 and 50, 30 and 50, 40 and 50, 10 and 40, 20 and 40, 30 and 40, 10 and 30, 20 and 30, or 10 and 20 wt % of the thermally conductive particles.

Example Ex 36. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, at least 10, 15, 20, 25, 30, 35, 40, 45, 50, or 55 wt % of the aerosol former.

Example Ex 37. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, no more than 55, 50, 45, 40, 35, 30, 25, 20, or 15 wt % of the aerosol former.

Example Ex 38. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, between 7 and 60, 10 and 60, 20 and 60, 30 and 60, 40 and 60, 50 and 60, 7 and 50, 10 and 50, 20 and 50, 30 and 50, 40 and 50, 7 and 40, 10 and 40, 20 and 40, 30 and 40, 7 and 30, 10 and 30, 20 and 30, 7 and 20, 10 and 20, or 7 and 10 wt % of the aerosol former, particularly preferably between 15 and 25 wt% of the aerosol former.

Example Ex 39. An aerosol-forming substrate according to any preceding example, wherein the aerosol-former comprises or consists of one or more of: polyhydric alcohols, such as propylene glycol, polyethylene glycol, triethylene glycol, 1, 3-butanediol and glycerine; esters of polyhydric alcohols, such as glycerol mono-, di- or tri-acetate; and aliphatic esters of mono-, di- or poly-carboxylic acids, such as dimethyl dodecanedioate and dimethyl tetradecanedioate.

Example Ex 40. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate comprises one or both of glycerine and glycerol.

Example Ex 41. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, at least 2, 4, 6, 8, 10, 12, 14, 16 or 18 wt % of the fibres.

Example Ex 42. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, no more than 20, 18, 16, 14, 12, 10, 8, 6, or 4 wt % of the fibres.

Example Ex 43. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, between 4 and 20, 6 and 20, 8 and 20, 10 and 20, 12 and 20, 14 and 20, 16 and 20, 18 and 20, 2 and 18, 4 and 18, 6 and 18, 8 and 18, 10 and 18, 12 and 18, 14 and 18, 16 and 18, 2 and 16, 4 and 16, 6 and 16, 8 and 16, 10 and 16, 12 and 16, 14 and 16, 2 and 14, 4 and 14, 6 and 14, 8 and 14, 10 and 14, 12 and 14, 2 and 12, 4 and 12, 6 and 12, 8 and 12, 10 and 12, 2 and 10, 4 and 10, 6 and 10, 8 and 10, 2 and 8, 4 and 8, 6 and 8, 2 and 6, 4 and 6, or 2 and 4 wt % of the fibres, particularly preferably between 2 and 10 wt% of the fibres.

Example Ex 44. An aerosol-forming substrate according to any preceding example, wherein the fibres are cellulose fibres.

Example Ex 45. An aerosol-forming substrate according to any preceding example, wherein each of the fibres has three mutually perpendicular dimensions, a largest dimension of the three dimensions being at least 1.5, 2, 3, 5, 10, or 20 times larger than a smallest dimension of the three dimensions.

Example Ex 46. An aerosol-forming substrate according to any preceding example, wherein each of the fibres has three mutually perpendicular dimensions, a largest dimension of the three dimensions being at least 1.5, 2, 3, 5, 10, or 20 times larger than a second largest dimension of the three dimensions.

Example Ex 47. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, at least 4, 6, or 8 wt % of the binder.

Example Ex 48. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, no more than 8, 6, or 4 wt % of the binder.

Example Ex 49. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, between 4 and 10, 6 and 10, 8 and 10, 2 and 8, 4 and 8, 6 and 8, 2 and 6, 4 and 6, 2 and 4 wt % of the binder, particularly preferably between 2 and 10 wt% of the binder.

Example Ex 50. An aerosol-forming substrate according to any preceding example, wherein the binder comprises or consists of one or both of carboxymethyl cellulose or hydroxypropyl cellulose.

Example Ex 51. An aerosol-forming substrate according to any preceding example, wherein the binder comprises or consists of one or more gums such as guar gum.

Example Ex 52. An aerosol-forming substrate according to any preceding example, wherein the thermally conductive particles are substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 53. An aerosol-forming substrate according to any preceding example, wherein the aerosol former is substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 54. An aerosol-forming substrate according to any preceding example, wherein the fibres are substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 55. An aerosol-forming substrate according to any preceding example, wherein the binder is substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 56. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises nicotine.

Example Ex 57. An aerosol-forming substrate according to example Ex 56, wherein the substrate comprises, on a dry weight basis, at least 0.01, 1, 2, 3, or 4 wt % nicotine.

Example Ex 58. An aerosol-forming substrate according to any of examples Ex 56 to Ex 57, wherein the substrate comprises, on a dry weight basis, no more than 5, 4, 3, 2, or 1 wt % nicotine.

Example Ex 59. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises, on a dry weight basis, between 0.01 and 5, 1 and 5, 2 and 5, 3 and 5, 4 and 5, 0.01 and 4, 1 and 4, 2 and 4, 3 and 4, 0.01 and 3, 1 and 3, 2 and 3, 0.01 and 2, 1 and 2, 0.01 and 1 wt % nicotine, particularly preferably between 0.5 and 4 wt% nicotine.

Example Ex 60. An aerosol-forming substrate according to any of examples Ex 56 to Ex 58, wherein the nicotine is substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 61. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises an acid.

Example Ex 62. An aerosol-forming substrate according to example Ex 61, wherein the substrate comprises, on a dry weight basis, at least 0.01, 1, or 2 wt % of the acid.

Example Ex 63. An aerosol-forming substrate according to any of examples Ex 61 to Ex 62, wherein the substrate comprises, on a dry weight basis, no more than 3, 2 or 1 wt % of the acid.

Example Ex 64. An aerosol-forming substrate according to any of examples Ex 61 to Ex 63, wherein the substrate comprises, on a dry weight basis, between 0.01 and 3, 1 and 3, 2 and 3, 0.01 and 2, 1 and 2, 0.01 and 1 wt % of the acid, particularly preferably between 0.5 and 5 wt% of the acid.

Example Ex 65. An aerosol-forming substrate according to any of examples Ex 61 to Ex 64, wherein the acid comprises or consists of one or more of fumaric acid, lactic acid, benzoic acid, and levulinic acid.

Example Ex 66. An aerosol-forming substrate according to any of examples Ex 61 to Ex 65, wherein the acid is substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 67. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises at least one botanical.

Example Ex 68. An aerosol-forming substrate according to example Ex 67, wherein the substrate comprises, on a dry weight basis, at least 0.01, 1, 2, 5, 10, or 15 wt % of the at least one botanical.

Example Ex 69. An aerosol-forming substrate according to any of examples Ex 67 to Ex 68, wherein the substrate comprises, on a dry weight basis, no more than 20, 15, 10, 5, 2 or 1 wt % of the at least one botanical.

Example Ex 70. An aerosol-forming substrate according to any of examples Ex 67 to Ex 69, wherein the substrate comprises, on a dry weight basis, between 0.01 and 20, 1 and 20, 2 and 20, 5 and 20, 10 and 20, 15 and 20, 0.01 and 15, 1 and 15, 2 and 15, 5 and 15, 10 and 15, 0.01 and 10, 1 and 10, 2 and 10, 5 and 10, 0.01 and 5, 1 and 5, 2 and 5, 0.01 and 2, 1 and 2, 0.01 and

1 wt % of the at least one botanical, particularly preferably between 1 and 15 wt% of the at least one botanical.

Example Ex 71. An aerosol-forming substrate according to any of examples Ex 67 to Ex 70, wherein the at least one botanical comprises or consists of one or both of clove and rosmarinus.

Example Ex 72. An aerosol-forming substrate according to any of examples Ex 67 to Ex 71, wherein the at least one botanical is substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 73. An aerosol-forming substrate according to any preceding example, wherein the substrate comprises at least one flavourant.

Example Ex 74. An aerosol-forming substrate according to example Ex 73, wherein the substrate comprises, on a dry weight basis, at least 0.1, 1, 2, or 5 wt % of the at least one flavourant.

Example Ex 75. An aerosol-forming substrate according to any of examples Ex 73 to Ex 74, wherein the substrate comprises, on a dry weight basis, no more than 10, 5, 2 or 1 wt % of the at least one flavourant.

Example Ex 76. An aerosol-forming substrate according to any of examples Ex 73 to Ex 75, wherein the substrate comprises, on a dry weight basis, between 0.1 and 10, 1 and 10, 2 and 10, 5 and 10, 0.1 and 5, 1 and 5, 2 and 5, 0.1 and 2, 1 and 2, 0.1 and 1 wt % of the at least one flavourant, particularly preferably between 0.1 and 5 wt% of the at least one flavourant.

Example Ex 77. An aerosol-forming substrate according to any of examples Ex 73 to Ex 76, wherein the at least one flavourant is present as a coating, for example a coating on one or more other components of the aerosol-forming substrate.

Example Ex 78. An aerosol-forming substrate according to any of examples Ex 73 to Ex 77, wherein the at least one flavourant is substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 79. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate comprises one or more organic materials such as tobacco.

Example Ex 80. An aerosol-forming substrate according to any preceding example, wherein the organic material comprises one or more of herb leaf, tobacco leaf, fragments of tobacco ribs, reconstituted tobacco, homogenised tobacco, extruded tobacco and expanded tobacco.

Example Ex 81. An aerosol-forming substrate according to any preceding example, wherein the organic materials are substantially homogeneously distributed throughout the aerosol-forming substrate.

Example Ex 82. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate is a tobacco-free aerosol-forming substrate.

Example Ex 83. An aerosol-forming substrate according to any preceding example, wherein some or each of the thermally conductive particles comprise a susceptor material.

Example Ex 84. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate has a thermal conductivity of at least 0.15, 0.2, 0.22, 0.3, 0.4, 0.5, 0.75, 1, 1.25, or 1.5 W/(mK) in at least one direction, or in all directions, at 25 degrees Celsius.

Example Ex 85. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate has a density of less than 1500, 1050, 1000, 950, 900, 850, 800, 850, 800, 750, 700, or 650 kg/m^3.

Example Ex 86. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate has a density of between 500 and 900 or 600 and 800 kg/m^3.

Example Ex 87. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate has a moisture content of between 1 and 20, or 3 and 15 wt %.

Example Ex 88. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate comprises between 1 and 20, or 3 and 15 wt % water.

Example Ex 89. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate comprises, or is in the form of, one or more of: cut-filler, powder particles, granules, pellets, shreds, spaghettis, strips or sheets.

Example Ex 90. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate comprises, or is in the form of, one or more sheets or strips.

Example Ex 91. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate comprises, or is in the form of, one or more gathered sheets.

Example Ex 92. An aerosol-forming substrate according to example Ex 91, wherein the or each gathered sheet has a width of at least about 5, 10, 25, 50, or 100 mm.

Example Ex 93. An aerosol-forming substrate according to any preceding example, wherein the aerosol-forming substrate comprises, or is in the form of, a plurality of strips.

Example Ex 94. An aerosol-forming substrate according to any of examples Ex 93, wherein each of the plurality of strips has a length of at least about 3, 5 or 10 mm.

Example Ex 95. An aerosol-forming substrate according to any of examples Ex 93 to Ex 94, wherein each of the plurality of strips has a width of less than about 3, 2 or 1 mm.

Example Ex 96. An aerosol-forming substrate according to any of examples Ex 90 to Ex 95, wherein the or each sheet or strip has a thickness of at least 100, 150, or 200 microns.

Example Ex 97. An aerosol-forming substrate according to any of examples Ex 90 to Ex 96, wherein the or each sheet or strip has a thickness of no more than 300, or 250 microns.

Example Ex 98. An aerosol-forming substrate according to any of examples Ex 90 to Ex 97, wherein the or each sheet or strip has a thickness of between 100 and 300, or 150 and 250, or 200 and 250 microns.

Example Ex 99. An aerosol-forming substrate according to any of examples Ex 90 to Ex 98, wherein the or each sheet or strip has a grammage of at least 20, 50, or 100 g/m^2.

Example Ex 100. An aerosol-forming substrate according to any of examples Ex 90 to Ex 99, wherein the or each sheet or strip has a grammage of no more than 300 g/m^2.

Example Ex 101. An aerosol-forming substrate according to any of examples Ex 90 to Ex 100, wherein the or each sheet or strip has a grammage of between 20 and 300, 50 and 250, or 100 and 250 g/m^2.

Example Ex 102. An aerosol-forming substrate according to any of examples Ex 90 to Ex 101, wherein the or each sheet or strip has a density of at least 0.1, 0.2, 0.3, or 0.5 g/m^3.

Example Ex 103. An aerosol-forming substrate according to any of examples Ex 90 to Ex 102, wherein the or each sheet or strip has a density of no more than 2, 1.5, 1.2, or 1 g/m^3.

Example Ex 104. An aerosol-forming substrate according to any of examples Ex 90 to Ex 103, wherein the or each sheet or strip has a density of between 0.1 and 2, 0.2 and 2, 0.3 and 2, 0.3 and 1.5, or 0.3 and 1.2 g/m^3.

Example Ex 105. A combined aerosol-forming substrate comprising:

a first material and a second material, the first material being comprised in the combined aerosol-forming substrate as a first plurality of discrete elements and the second material being comprised in the combined aerosol-forming substrate as a second plurality of discrete elements,

in which the first material comprises an aerosol former and has a first thermal conductivity,

in which the second material has a second thermal conductivity that is greater than the first thermal conductivity.

Example Ex 106. A combined aerosol-forming substrate according to example Ex 105 in which the second material comprises, or is, an aerosol-forming substrate according to any of examples Ex 1 to Ex 104.

Example Ex 107. A combined aerosol-forming substrate according to example Ex 105 or Ex 106 in which the second thermal conductivity is at least 5% greater than the first thermal conductivity, for example at least 7% greater, or at least 10% greater, or at least 12% greater, or at least 15% greater.

Example Ex 108. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 107 in which the thermal conductivity of the second material is at least 10% greater than the thermal conductivity of the first material, for example at least 12% greater, or at least 15% greater, or at least 20% greater.

Example Ex 109. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 108 in which the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements, are elongated elements, each having a length dimension that is greater than a width dimension and a thickness dimension.

Example Ex 110. A combined aerosol-forming substrate according to example Ex 109 in which the elongated elements are in the form of strips, shreds, threads, or ribbons.

Example Ex 111. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 110 in which the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements, are formed by a casting process, for example by a casting process followed by a cutting process.

Example Ex 112. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 111 in which the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements, are formed by an extrusion process.

Example Ex 113. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 112 in which at least a portion of the first plurality of discrete elements, or at least a portion of the second plurality of discrete elements, or at least a portion of both the first and second plurality of discrete elements, are crimped elements, for example in which each crimped element has one or more kinks or directional changes defined in a length dimension of the crimped element.

Example Ex 114. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 113 in which one or both of the first material and the second material is comprised in the combined aerosol-forming substrate in the form of cut filler.

Example Ex 115. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 114 in which the discrete elements of the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements have an average thickness of between 5 microns and 2000 microns, for example between 50 microns and 500 microns, for example between 150 microns and 300 microns.

Example Ex 116. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 115 in which the discrete elements of the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements have an average width of between 100 microns and 2000 microns, for example between 500 microns and 1500 microns, for example between 600 microns and 1000 microns.

Example Ex 117. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 116 in which the discrete elements of the first plurality of discrete elements, or the second plurality of discrete elements, or both the first and second plurality of discrete elements have an average length of between 100 microns and 60 millimetres, for example between 500 microns and 30 millimetres microns, for example between 1000 microns and 10000 microns.

Example Ex 118. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 117 in which the second material comprises thermally conductive particles.

Example Ex 119. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 118 in which the second material comprises between 1% and 50% thermally conductive particles on a dry weight basis.

Example Ex 120. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 119 in which the second material comprises thermally conductive particles formed from a thermally conductive material selected from the list consisting of carbon, graphite, expanded graphite, graphene, and metal.

Example Ex 121. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 120 in which the second material is a thermally conductive material selected from the list consisting of carbon, graphite, expanded graphite, graphene, and metal, for example in which each discrete element of the second material is a strip of metal foil or carbon foil, for example copper foil, or aluminium foil, or stainless steel foil, or graphite foil.

Example Ex 122. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 121 in which the first material has a thermal conductivity of less than 0.2 W/(mK) at 25 degrees Celsius, and the second material has a thermal conductivity of greater than 0.1, 0.22, 0.3, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 1500, or 1700 W/(mK) at 25 degrees Celsius.

Example Ex 123. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 122 in which the first material is configured to generate an aerosol on heating, for example on heating to a temperature of between 120 degrees Celsius and 395 degrees Celsius, and the second material is not configured to generate an aerosol on heating, for example on heating to a temperature of between 120 degrees Celsius and 350 degrees Celsius.

Example Ex 124. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 123 in which both the first material and the second material are configured to generate an aerosol on heating, for example on heating to a temperature of between 120 degrees Celsius and 395 degrees Celsius.

Example Ex 125. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 124 in which the first material comprises tobacco, for example in which the first material is formed from homogenised tobacco.

Example Ex 126. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 125 in which the first material comprises tobacco and an aerosol-former, and is configured to generate an aerosol when heated to a temperature of between 120 degrees Celsius and 395 degrees Celsius.

Example Ex 127. A combined aerosol-forming substrate according to example Ex 126 in which the first material is a homogenised tobacco material, and further comprises fibres and a binder.

Example Ex 128. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 127 in which the second material comprises an aerosol-former and conductive particles constituting between 3 wt % and 90 wt % of the second material on a dry weight basis, the second material being configured to generate an aerosol when heated to a temperature of between 120 degrees Celsius and 395 degrees Celsius.

Example Ex 129. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 128 in which the second material comprises tobacco and an aerosol-former and conductive particles constituting between 3 wt % and 90 wt % of the second material on a dry weight basis, the second material being configured to generate an aerosol when heated to a temperature of between 120 degrees Celsius and 395 degrees Celsius.

Example Ex 130. A combined aerosol-forming substrate according to example Ex 129 in which the second material is a thermally conductive homogenised tobacco material, and further comprises fibres and a binder.

Example Ex 131. A combined aerosol-forming substrate according to example Ex 128 in which the second material does not comprise tobacco, for example in which the second material is a thermally conductive tobacco-free material, and further comprises fibres and a binder.

Example Ex 132. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 131 in which the discrete elements of the first material and the discrete elements of the second material are formed separately and mixed together in a predetermined ratio to form the combined aerosol-forming material.

Example Ex 133. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 132 in which the ratio of the first material to second material in the combined aerosol-forming substrate is between 1:10 and 10:1, for example between 1:5 and 8:1, for example between 1:1 and 5:1.

Example Ex 134. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 133 in which the second material comprises, on a dry weight basis: between 40 and 80 wt % of particulate carbon material; between 10 and 40 wt % of an aerosol former; between 4 and 20 wt % of fibres; and between 2 and 10 wt % of a binder, wherein the particulate carbon material consists of one or more of graphite, expanded graphite, graphene, carbon nanotubes, and charcoal.

Example Ex 135. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 134 in which the first material comprises, on a dry weight basis: between 40 and 80 wt % of particulate carbon material; between 10 and 40 wt % of an aerosol former; between 4 and 20 wt % of fibres; and between 2 and 10 wt % of a binder, wherein the particulate carbon material consists of one or more of graphite, expanded graphite, graphene, carbon nanotubes, and charcoal, the first material having a lower thermal conductivity than the second material.

Example Ex 136. A combined aerosol-forming substrate according to example Ex 135, wherein the particulate carbon material consists of graphite.

Example Ex 137. A combined aerosol-forming substrate according to any of examples Ex 105 to Ex 136 in which the second material and the first material are homogeneously distributed within the combined aerosol-forming substrate.

Example Ex 138. A method of forming a combined aerosol-forming substrate, for example a combined aerosol-forming substrate according to any of examples Ex 105 to Ex 137, comprising steps of forming a first plurality of discrete elements from a first material; forming a second plurality of discrete elements from a second material, and combining the first plurality of discrete elements with the second plurality of discrete elements to form the combined aerosol-forming substrate, in which the second material has a greater thermal conductivity than the first material.

Example Ex 139. A method of forming a combined aerosol-forming substrate, for example a combined aerosol-forming substrate according to any of examples Ex 105 to Ex 137, comprising steps of providing a first plurality of discrete elements from a first material; providing a second plurality of discrete elements from a second material, and combining the first plurality of discrete elements with the second plurality of discrete elements to form the combined aerosol-forming substrate, in which the second material has a greater thermal conductivity than the first material.

Example Ex 140. A method according to Example Ex 138 or Ex 139 in which the first plurality of discrete elements are formed by cutting a sheet of the first material into strips, and in which the second plurality of discrete elements are formed by cutting a sheet of the second material into strips.

Example Ex 141. A method according to Example Ex 140 in which the first plurality of discrete elements and the second plurality of discrete elements are cut to be substantially the same size.

Example Ex 142. A method according to any of examples Ex 138 to Ex 141 in which the step of forming at least one of the first plurality of discrete elements and the second plurality of discrete elements involves a step of crimping, for example such that the first plurality of discrete elements, the second plurality of discrete elements, or both the first and second plurality of discrete elements are crimped elements.

Example Ex 143. A method according to any of examples Ex 138 to Ex 142, further comprising the steps of forming the first material, forming the second material, or forming both the first and the second material.

Example Ex 144. A method according to any of examples Ex 138 to Ex 143 in which the combined aerosol-forming substrate is a combined aerosol-forming substrate as described in relation to any of examples Ex 105 to Ex 137.

Example Ex 145. An aerosol-generating article comprising a combined aerosol-forming substrate as defined in any of examples Ex 105 to Ex 137 or manufactured by any method defined in examples any of examples Ex 138 to Ex 144.

Example Ex 146. An aerosol-generating article according to example Ex 145 in which the article is in the form of a rod and comprises a plurality of components, including the combined aerosol-forming substrate, assembled within a wrapper or casing.

Example Ex 147. An aerosol-generating article comprising an aerosol-forming substrate or combined aerosol-forming substrate according to any preceding example.

Example Ex 148. An aerosol-generating article according to example Ex 147, wherein the aerosol-generating article comprises a front plug.

Example Ex 149. An aerosol-generating article according to any of examples Ex 147 to Ex 148, wherein the aerosol-generating article comprises a first hollow tube, for example a first hollow acetate tube.

Example Ex 150. An aerosol-generating article according to any of examples Ex 147 to Ex 148, wherein the aerosol-generating article comprises a second hollow tube, for example a second hollow acetate tube.

Example Ex 151. An aerosol-generating article according to example Ex 150, wherein the second hollow tube comprises one or more ventilation holes.

Example Ex 152. An aerosol-generating article according to any of examples Ex 147 to Ex 151, wherein the aerosol-generating article comprises a mouth plug filter.

Example Ex 153. An aerosol-generating article according to any of examples Ex 147 to Ex 152, wherein the aerosol-generating article comprises wrapper, for example a paper wrapper.

Example Ex 154. An aerosol-generating article according to any of examples Ex 147 to Ex 153, wherein the aerosol-generating article comprises a front plug, the aerosol-forming substrate arranged downstream of the front plug, a first hollow tube arranged downstream of the aerosol-forming substrate, a second hollow tube arranged downstream of the first hollow tube, and a mouth plug filter arranged downstream of the second hollow tube.

Example Ex 155. An aerosol-generating article according to example Ex 154, wherein the front plug, the aerosol-forming substrate, the first hollow tube, the second hollow tube, and the mouth plug filter are circumscribed by a wrapper, for example a paper wrapper.

Example Ex 156. An aerosol-generating article according to any of examples Ex 148 or Ex 149 to Ex 155 when dependent on example Ex 148, wherein the front plug has a length of between 2 and 10, 3 and 8, or 4 and 6 mm, for example around 5 mm.

Example Ex 157. An aerosol-generating article according to any of examples Ex 147 to Ex 156, wherein the aerosol-forming substrate has a length of between 5 and 20, 8 and 15, or 10 and 15 mm, for example around 12 mm.

Example Ex 158. An aerosol-generating article according to any of examples Ex 149 or Ex 150 to Ex 157 when dependent on example Ex 149, wherein the first hollow tube has a length of between 2 and 20, 5 and 15, or 5 and 10 mm, for example around 8 mm.

Example Ex 159. An aerosol-generating article according to any of examples Ex 150 or Ex 151 to Ex 158 when dependent on example Ex 150, wherein the second hollow tube has a length of between 2 and 20, 5 and 15, or 5 and 10 mm, for example around 8 mm.

Example Ex 160. An aerosol-generating article according to any of examples Ex 152 or Ex 153 to Ex 159 when dependent on example Ex 152, wherein the mouth plug filter has a length of between 5 and 20, 8 and 15, or 10 and 15 mm, for example around 12 mm.

Example Ex 161. An aerosol-generating system comprising an aerosol-generating article according to any of examples Ex 145 to Ex 160 and an electrical aerosol-generating device.

Example Ex 162. An aerosol-generating system according to example Ex 161, wherein the electrical aerosol-generating device is configured to resistively heat the aerosol-generating article in use.

Example Ex 163. An aerosol-generating system according to any of examples Ex 161 to Ex 162, wherein the electrical aerosol-generating device is configured to inductively heat the aerosol-generating article, for example the aerosol forming substrate of the aerosol-generating article, in use.

Example Ex 164. A method of forming an aerosol-forming substrate according to any preceding aerosol-forming substrate example, for example any of examples Ex 1 to Ex 104, the method comprising:

forming a slurry comprising the thermally conductive particles, the aerosol former, the fibres, and the binder; and

casting and drying the slurry to form the aerosol-forming substrate or a precursor for forming into the aerosol-forming substrate.

Example Ex 165. A method according to example Ex 164, wherein the slurry comprises water.

Example Ex 166. A method according to any of examples Ex 164 to Ex 165, wherein the slurry comprises between 40 and 90, 40 and 85, 50 and 80, 60 and 80, 60 and 75 wt % water.

Example Ex 167. A method according to any of examples Ex 164 to Ex 166, wherein the slurry comprises an acid such as fumaric acid.

Example Ex 168. A method according to any of examples Ex 164 to Ex 167, wherein the slurry comprises nicotine.

Example Ex 169. A method according to any of examples Ex 164 to Ex 168, wherein forming the slurry comprises:

forming a first mixture comprising:
    the aerosol former;
    the fibres;
    water;
    optionally, the acid; and
    optionally, the nicotine,
forming a second mixture comprising:
    the thermally conductive particles; and
    the binder,
and adding the second mixture to the first mixture to form a combined mixture.

Example Ex 170. A method according to example Ex 170, wherein forming the first mixture comprises providing the aerosol former or a solution comprising the aerosol former and the nicotine.

Example Ex 171. A method according to example Ex 171, wherein forming the first mixture comprises adding the acid to the aerosol former or the solution comprising the aerosol former and the nicotine to form a first pre-mixture.

Example Ex 172. A method according to any of examples Ex 170 to Ex 171, wherein forming the first mixture comprises adding the water to the aerosol former or the solution comprising the aerosol former and the nicotine, or to the first pre-mixture, to form a second pre-mixture.

Example Ex 173. A method according to any of examples Ex 169 to Ex 172, wherein forming the first mixture comprises adding the fibres to the second pre-mixture.

Example Ex 174. A method according to any of examples Ex 169 to Ex 173, wherein forming the second mixture comprises mixing the thermally conductive particles and the binder.

Example Ex 175. A method according to any of examples Ex 169 to Ex 174, wherein the method comprises a first mixing of the combined mixture.

Example Ex 176. A method according to example Ex 175, wherein the first mixing occurs under a first pressure of no more than 500, 400, 300, 250, or 200 mbar.

Example Ex 177. A method according to example Ex 175 or Ex 176, wherein the first mixing occurs for between 1 and 10, 2 and 8, or 3 and 6 minutes, for example for around 4 minutes.

Example Ex 178. A method according to any of examples Ex 175 to Ex 177, wherein the method comprises, after mixing the first mixing, a second mixing.

Example Ex 179. A method according to example Ex 178, wherein the second mixing occurs under a second pressure which is less than the first pressure.

Example Ex 180. A method according to example Ex 179, wherein the second pressure is no more than 500, 400, 300, 200, 150, or 100 mbar.

Example Ex 181. A method according to example Ex 178 or Ex 179 or Ex 180, wherein the second mixing occurs for between 5 and 120, 5 and 80, 5 and 40, or 10 and 30 seconds, for example around 20 seconds.

Example Ex 182. A method according to any of examples Ex 164 to Ex 181, wherein casting the slurry comprises casting the slurry onto a flat support, for example a steel flat support.

Example Ex 183. A method according to any of examples Ex 164 to Ex 182, wherein after casting the slurry and before drying the slurry, the method comprises setting a thickness of the slurry, for example setting a thickness of the slurry to between 100 and 1,000, 200 and 900, 300 and 800, 500 and 700 microns, for example around 600 microns.

Example Ex 184. A method according to any of examples Ex 164 to Ex 183, wherein drying the slurry comprises providing a flow of a gas such as air over or past the slurry.

Example Ex 185. A method according to example Ex 184, wherein the flow of gas is heated.

Example Ex 186. A method according to example Ex 185, wherein the flow of gas is heated to a temperature of between 100 and 160, or 120 and 140 degrees Celsius.

Example Ex 187. A method according to any of examples Ex 184 to Ex 186, wherein the flow of gas is provided for between 1 and 10 or 2 and 5 minutes.

Example Ex 188. A method according to any of examples Ex 164 to Ex 187, wherein drying the slurry comprises drying the slurry until the slurry has a moisture content of between 1 and 20, 2 and 15, 2 and 10, or 3 and 7 wt %.

Example Ex 189. A method according to any of examples Ex 164 to Ex 188, wherein drying the slurry forms the precursor for forming into the aerosol-forming substrate, the precursor being a sheet of aerosol-forming material.

Example Ex 190. A method according to example Ex 189, wherein the method comprises cutting the sheet of aerosol-forming material.

Examples will now be further described with reference to the figures in which:

Figure 1 shows a schematic cross-sectional view of a first embodiment of an aerosol-generating article;

Figure 2 shows a schematic cross-sectional view of a second embodiment of an aerosol-generating article;

Figure 3 shows a schematic cross-sectional view of a first embodiment of an aerosol-generating system;

Figure 4 shows a schematic cross-sectional view of a second embodiment of an aerosol-generating system; and

Figure 5 shows a schematic cross-sectional view of a third embodiment of an aerosol-generating article.

Figure 1 shows a schematic cross-sectional view of a first embodiment of an aerosol-generating article 10. The aerosol-generating article 10 extends from an upstream or distal end 18 to a downstream or proximal or mouth end 20 and has an overall length of about 45 millimetres.

The aerosol-generating article 10 comprises a rod 12 of aerosol-forming substrate and a downstream section 14 at a location downstream of the rod 12 of aerosol-forming substrate. Further, the aerosol-generating article 10 comprises an upstream section 16 at a location upstream of the rod 12 of aerosol-forming substrate.

The downstream section 14 comprises a support element 22 located immediately downstream of the rod 12 of aerosol- forming substrate, the support element 22 being in longitudinal alignment with the rod 12. In the embodiment of Figure 1, the upstream end of the support element 22 abuts the downstream end of the rod 12 of aerosol-generating substrate. In addition, the downstream section 14 comprises an aerosol-cooling element 24 located immediately downstream of the support element 22, the aerosol-cooling element 24 being in longitudinal alignment with the rod 12 and the support element 22. In the embodiment of Figure 1, the upstream end of the aerosol-cooling element 24 abuts the downstream end of the support element 22.

As will become apparent from the following description, the support element 22 and the aerosol-cooling element 24 together define an intermediate hollow section 50 of the aerosol-generating article 10. As a whole, the intermediate hollow section 50 does not substantially contribute to the overall RTD of the aerosol-generating article. An RTD of the intermediate hollow section 26 as a whole is substantially 0 millimetres H_2O.

The support element 22 comprises a first hollow tubular segment 26. The first hollow tubular segment 26 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The first hollow tubular segment 26 defines an internal cavity 28 that extends all the way from an upstream end 30 of the first hollow tubular segment 26 to a downstream end 32 of the first hollow tubular segment 26. The internal cavity 28 is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity 28. As such, the first hollow tubular segment 26 – and, as a consequence, the support element 22 – does not substantially contribute to the overall RTD of the aerosol-generating article 10. In more detail, the RTD of the first hollow tubular segment 26 (which is essentially the RTD of the support element 22) is substantially 0 millimetres H_2O.

The first hollow tubular segment 26 has a length of about 8 millimetres, an external diameter of about 7.25 millimetres, and an internal diameter (D_{FTS}) of about 1.9 millimetres. Thus, a thickness of a peripheral wall of the first hollow tubular segment 26 is about 2.67 millimetres.

The aerosol-cooling element 24 comprises a second hollow tubular segment 34. The second hollow tubular segment 34 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The second hollow tubular segment 34 defines an internal cavity 36 that extends all the way from an upstream end 38 of the second hollow tubular segment to a downstream end 40 of the second hollow tubular segment 34. The internal cavity 36 is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity 36. The second hollow tubular segment 28 – and, as a consequence, the aerosol-cooling element 24 – does not substantially contribute to the overall RTD of the aerosol-generating article 10. In more detail, the RTD of the second hollow tubular segment 34 (which is essentially the RTD of the aerosol-cooling element 24) is substantially 0 millimetres H_2O.

The second hollow tubular segment 34 has a length of about 8 millimetres, an external diameter of about 7.25 millimetres, and an internal diameter (D_{STS}) of about 3.25 millimetres. Thus, a thickness of a peripheral wall of the second hollow tubular segment 34 is about 2 millimetres. Thus, a ratio between the internal diameter (D_{FTS}) of the first hollow tubular segment 26 and the internal diameter (D_{STS}) of the second hollow tubular segment 34 is about 0.75.

The aerosol-generating article 10 comprises a ventilation zone 60 provided at a location along the second hollow tubular segment 34. In more detail, the ventilation zone is provided at about 2 millimetres from the upstream end of the second hollow tubular segment 34. In this embodiment, the ventilation zone 60 comprises a circumferential row of perforations through a paper wrapper 70 and a ventilation level of the aerosol-generating article 10 is about 25 percent.

In the embodiment of Figure 1, the downstream section 14 further comprises a mouthpiece element 42, also referred to as a mouth plug filter, at a location downstream of the intermediate hollow section 50. In more detail, the mouthpiece element 42 is positioned immediately downstream of the aerosol-cooling element 24. As shown in the drawing of Figure 1, an upstream end of the mouthpiece element 42 abuts the downstream end 40 of the aerosol-cooling element 24.

The mouthpiece element 42 is provided in the form of a cylindrical plug of low-density cellulose acetate.

The mouthpiece element 42 has a length of about 12 millimetres and an external diameter of about 7.25 millimetres. The RTD of the mouthpiece element 42 is about 12 millimetres H_2O. The ratio of the length of the mouthpiece element 42 to the length of the intermediate hollow section 50 is approximately 0.6.

The rod 12 of aerosol-forming substrate has an external diameter of about 7.25 millimetres and a length of about 12 millimetres.

The upstream section 16 comprises an upstream element 46, also referred to as a front plug, located immediately upstream of the rod 12 of aerosol-forming substrate, the upstream element 46 being in longitudinal alignment with the rod 12. In the embodiment of Figure 1, the downstream end of the upstream element 46 abuts the upstream end of the rod 12 of aerosol-forming substrate. The upstream element 46 is provided in the form of a cylindrical plug of cellulose acetate. The upstream element 46 has a length of about 5 millimetres. The RTD of the upstream element 46 is about 30 millimetres H_2O.

The upstream element 46, rod 12 of aerosol-forming substrate, support element 22, aerosol-cooling element 24, and mouthpiece element 42 are circumscribed by a paper wrapper 70.

The rod 12 of aerosol-forming substrate comprises, on a dry weight basis, around 76.1 wt % thermally conductive particles 44. In this embodiment, the thermally conductive particles 44 are graphite particles, specifically FP 99,5 (>99.5% purity) graphite particles from Graphit Kropfmül GmbH, AMG Graphite GK, though other particles or mixtures of particles could be used. Each thermally conductive particle has a thermal conductivity of around 6 W/(mK) in at least one direction at 25 degrees Celsius.

The rod 12 of aerosol-forming substrate comprises, on a dry weight basis, around 17.7 wt % of an aerosol former. In this embodiment, the aerosol former is glycerol, specifically ICOF Europe fodd grade (>99.5% purity) glycerol.

The rod 12 of aerosol-forming substrate comprises, on a dry weight basis, around 3.9 wt % of fibres. In this embodiment, the fibres are cellulose fibres, specifically Birch cellulose fibers from Stora Enso OYJ.

The rod 12 of aerosol-forming substrate comprises, on a dry weight basis, around 2.3 wt % of a binder. In this embodiment, the binder is a guar gum, specifically guar gum from Gumix International Inc.

The rod 12 of aerosol-forming substrate comprises about 10 wt % water, when measured at 25 degrees Celsius.

In other embodiments, the rod 12 of aerosol-forming substrate further comprises one or more of nicotine, an acid such as fumaric acid, a botanical such as clove or rosmarinus, and a flavourant.

The aerosol-forming substrate has a thermal conductivity of at least 0.1 W/(mK) in at least one direction at 25 degrees Celsius. The aerosol-forming substrate may have a thermal conductivity of 0.2, 0.5, 1, 1.5 or greater W/(mK) in at least one direction at 25 degrees Celsius

Each of the thermally conductive particles 44 is substantially spherical in shape. The thermally conductive particles 44 are substantially homogeneously distributed throughout the aerosol-forming substrate. The particle size distribution has a volume D10 particle size of around

6 microns, a volume D50 particle size of around 20 microns, and a volume D90 particle size of around 56 microns. Each of the thermally conductive particles 44 has a particle size greater than around 1 microns and less than around 300 microns.

The thermally conductive particles 44 have a density of around 2200 kilograms per metre cubed. The aerosol-forming substrate has a density of around 800 kilograms per metre cubed.

The rod 12 of aerosol-forming substrate is formed by the process set out below.

A slurry is formed using a lab disperser capable of mixing viscous liquids, dispersing powders through liquids, and removing gas from a mixture (for example by applying a vacuum or other suitably low pressure). In this embodiment, a commercially available lab disperser from PC Laborsystem was used.

To form the slurry, a first mixture is formed by adding to the lap disperser around 7.11 grams of the aerosol former, then around 157.5 grams of water, then around 1.57 grams of the fibres. Then, these first ingredients are mixed at 25 degrees Celsius for 5 minutes at 600-700 rpm to ensure a homogeneous mixture and to hydrate the fibers. Then, a second mixture is formed by manually mixing around 32.95 grams of the thermally conductive particles and around 0.92 grams of the binder. This mixing of the second mixture avoids the formation of lumps in the lab dispersion. Then, the second mixture is added to the first mixture to form a combined mixture. Then, the combined mixture is mixed at 5000 rpm for 4 minutes at 25 degrees Celsius and a first reduced pressure of around 200 mbar. The reduced pressure may help to ensure that the thermally conductive particles are homogeneously dispersed in the mixture and that there is little trapped air and few lumps in the combined mixture. Then, the combined mixture is mixed at 5000 rpm for 20 second minutes at 25 degrees Celsius and a second reduced pressure of around 100 mbar. This second reduced pressure may help to remove any remaining air bubbles. This forms a slurry for casting.

The slurry is then casted and dried using a suitable apparatus. In this embodiment, a commercially available Labcoater Mathis apparatus is used. This apparatus includes a stainless steel, flat support, and a coma blade for adjusting a thickness of slurry cast onto the flat support.

The slurry is cast onto the flat support and a gap between the coma blade and the flat support is set at 0.6 millimetres. This ensures that a thickness of the slurry is no more than 0.6 millimetres at any given point.

The slurry is then dried with hot air between 120 and 140 degrees Celsius for between 2 and 5 minutes. After this drying, a sheet of the aerosol-forming substrate is formed. This sheet has a thickness of around 159 microns, a grammage of around 125.7 grams per metre squared, and a density of around 0.79 kilograms per metre cubed.

The sheet is then gathered and cut to form the rod 12 of aerosol-forming substrate. In other embodiments, the sheet is also crimped.

After forming the rod 12 of aerosol-forming substrate, the aerosol-generating article 10 is assembled by positioning the various components of the article 10 and wrapping the components in the wrapper 70.

Figure 2 shows a schematic cross-sectional view of a second embodiment of an aerosol-generating article 11. This second embodiment is identical to the first embodiment of Figure 1 except that the rod 12 of aerosol-forming substrate has been replaced by an alternative rod 13 of a combined aerosol-forming substrate. Identical reference numerals have been used for identical components in the embodiments of Figures 1 and 2.

In the rod 13 of the second embodiment, the combined aerosol-forming substrate comprises a first material and a second material. The first material is comprised in the combined aerosol-forming substrate as a first plurality of discrete elements and the second material is comprised in the combined aerosol-forming substrate as a second plurality of discrete elements. In this embodiment, the first material and the second material are equally abundant by weight in the combined aerosol-forming substrate. In other embodiments, however, more or less of the first material may be present in the combined aerosol-forming substrate than the second material.

In this embodiment, the elements of both the first and second plurality of discrete elements have an average thickness of between 150 microns and 300 microns, an average width of between 600 microns and 1000 microns, and an average length of between 1000 microns and 10000 microns.

The first material may be a conventional tobacco cut-filler. As such, the first material may be formed by a conventional tobacco cut-filler manufacturing process and may comprise an aerosol former, fibres and a binder, but does not comprise any thermally conductive particles. As an example, the first material may be made using a similar method to that set out above for the rod 12 of aerosol-forming substrate of the first embodiment of Figure 1, except that no thermally conductive particles are included and, rather than gathering and cutting the sheet to form the rod 12, the sheet is shredded to form reconstituted cut-filler.

The second material is formed from a similar aerosol-forming substrate to that of the rod 12 in the first embodiment of Figure 1. The second material comprises on a dry weight basis, around 76.1 wt % thermally conductive particles 45, around 17.7 wt % of an aerosol former, around 3.9 wt % of fibres, and around 2.3 wt % of a binder. In the second material, the thermally conductive particles are all either graphite particles or expanded graphite particles, though other particles or mixtures of particles could be used.

The first material has a first thermal conductivity and the second material has a second thermal conductivity at least 10% greater than the first thermal conductivity. Thus, the second material helps to increase the thermal conductivity of the combined aerosol-forming substrate.

The rod 13 of combined aerosol-forming substrate is formed by the process set out below.

A slurry is formed using a lab disperser capable of mixing viscous liquids, dispersing powders through liquids, and removing gas from a mixture (for example by applying a vacuum or other suitably low pressure). In this embodiment, a commercially available lab disperser from PC Laborsystem was used.

To form the slurry, a first mixture is formed by adding to the lap disperser around 7.11 grams of the aerosol former, then around 157.5 grams of water, then around 1.57 grams of the fibres. Then, these first ingredients are mixed at 25 degrees Celsius for 5 minutes at 600-700 rpm to ensure a homogeneous mixture and to hydrate the fibers. Then, a second mixture is formed by manually mixing around 32.95 grams of the thermally conductive particles and around 0.92 grams of the binder. This mixing of the second mixture avoids the formation of lumps in the lab dispersion. Then, the second mixture is added to the first mixture to form a combined mixture. Then, the combined mixture is mixed at 5000 rpm for 4 minutes at 25 degrees Celsius and a first reduced pressure of around 200 mbar. The reduced pressure may help to ensure that the thermally conductive particles are homogeneously dispersed in the mixture and that there is little trapped air and few lumps in the combined mixture. Then, the combined mixture is mixed at 5000 rpm for 20 second minutes at 25 degrees Celsius and a second reduced pressure of around 100 mbar. This second reduced pressure may help to remove any remaining air bubbles. This forms a slurry for casting.

The slurry is then casted and dried using a suitable apparatus. In this embodiment, a commercially available Labcoater Mathis apparatus is used. This apparatus includes a stainless steel, flat support, and a coma blade for adjusting a thickness of slurry cast onto the flat support.

The slurry is cast onto the flat support and a gap between the coma blade and the flat support is set at 0.6 millimetres. This ensures that a thickness of the slurry is no more than 0.6 millimetres at any given point.

The slurry is then dried with hot air between 120 and 140 degrees Celsius for between 2 and 5 minutes. After this drying, a sheet of the aerosol-forming substrate is formed. This sheet has a thickness of around 159 microns, a grammage of around 125.7 grams per metre squared, and a density of around 0.79 kilograms per metre cubed.

The sheet is then shredded to form a plurality of discrete elements of the aerosol-forming substrate. In other words, the sheet is then cut to form the second material present in the combined aerosol-forming substrate as a second plurality of discrete elements.

This second material is then mixed with the first material, which is a first plurality of discrete elements. As set out above, the first material may be formed using a conventional tobacco cut-filler manufacturing process. This is therefore not explained in detail here.

The mixed first and second materials present as pluralities of discrete elements are then formed into the rod 13 of combined aerosol-forming substrate, for example by circumscribing in a wrapper.

Then, after forming the rod 13 of combined aerosol-forming substrate, the aerosol-generating article 11 is assembled by positioning the various components of the article 11 and wrapping the components in the wrapper 70.

Figure 3 shows a schematic cross-sectional view of a first embodiment of an aerosol-generating system 100. The system 100 comprises an aerosol-generating device 102 and the aerosol-generating article 10 of Figure 1, though the device 102 could equally be used with the aerosol-generating article 11 of Figure 2.

The aerosol-generating device 102 comprises a battery 104, a controller 106, a heating blade 108 coupled to the battery, and a puff-detection mechanism (not shown). The controller 106 is coupled to the battery 104, the heating blade 108 and the puff-detection mechanism.

The aerosol-generating device 102 further comprises a housing 110 defining a substantially cylindrical cavity for receiving a portion of the article 10. The heating blade 108 is positioned centrally within the cavity and extends longitudinally from a base of the cavity.

In this embodiment, the heating blade 108 comprises a substrate and an electrically resistive track located on the substrate. The battery 104 is coupled to the heating blade 108 so as to be able to pass a current through the electrically resistive track and heat the electrically resistive track and heating blade 108 to an operational temperature.

In use, a user inserts the article 10 into the cavity, causing the heating blade 108 to penetrate the upstream element 46 and rod 12 of aerosol-forming substrate of the article 10. Figure 3 shows the article 10 inserted into the cavity of the device 102.

Then, the user puffs on the downstream end of the article 10. This causes air to flow through an air inlet (not shown) of the device 102, then through the article 10, from the upstream end 18 to the downstream end 20, and into the mouth of the user.

The user puffing on the article 10 causes air to flow through the air inlet of the device. The puff-detection mechanism detects that the air flow rate through the air inlet has increased to greater than a non-zero threshold flow rate. The puff-detection mechanism sends a signal to the controller 106 accordingly. The controller 106 then controls the battery 104 so as to pass a current through the electrically resistive track and heat up the heating blade 108. This heats up the rod 12 of aerosol-forming substrate, which is in contact with the heating blade 108.

The thermally conductive particles 44 have a significantly higher thermal conductivity than the surrounding aerosol-forming material. As such, these particles may act as local hot-spots and provide a more even temperature throughout the aerosol-forming substrate, particularly in a radial direction from the heating blade 108 where, with prior art substrates, there would be a significant temperature gradient. This may result in a greater proportion of the aerosol-forming substrate reaching a sufficiently high temperature to release volatile compounds, and thus a higher usage efficiency of the aerosol-forming substrate.

Heating of the aerosol-forming substrate cause the aerosol-forming substrate to release volatile compounds. These compounds are entrained by the air flowing from the upstream end 18 of the article 10 towards the downstream end 20 of the article 10. The compounds cool and condense to form an aerosol as they pass through the internal cavities 28, 36 of the support element 22 and the aerosol-cooling element 24. The aerosol then passes through the mouthpiece element 42, which may filter out unwanted particles entrained in the air flow, and into the mouth of the user.

When the user stops inhaling on the article 10, the air flow rate through the air inlet of the device decreases to less than the non-zero threshold flow rate. This is detected by the puff-detection mechanism. The puff-detection mechanism sends a signal to the controller 106 accordingly. The controller 106 then controls the battery 104 so as to reduce the current being passed through the electrically resistive track to zero.

After a number of puffs on the article 10, the user may choose to replace the article 10 with a fresh article.

Figure 4 shows a schematic cross-sectional view of a second embodiment of an aerosol-generating system 200. The system 200 comprises an aerosol-generating device 202 and the aerosol-generating article 11 of Figure 2, though the device 202 could equally be used with the aerosol-generating article 10 of Figure 1.

The aerosol-generating device 202 comprises a battery 204, a controller 206, an inductor coil 208, and a puff-detection mechanism (not shown). The controller 206 is coupled to the battery 204, the inductor coil 208 and the puff-detection mechanism.

The aerosol-generating device 202 further comprises a housing 210 defining a substantially cylindrical cavity for receiving a portion of the article 11. The inductor coil 208 spirals around the cavity.

The battery 204 is coupled to the inductor coil 208 so as to be able to pass an alternating current through the inductor coil 208.

In use, a user inserts the article 11 into the cavity. Figure 4 shows the article 11 inserted into the cavity of the device 202.

Then, the user puffs on the downstream end of the article 11. This causes air to flow through an air inlet (not shown) of the device 202, then through the article 11, from the upstream end 18 to the downstream end 20, and into the mouth of the user.

The user puffing on the article 11 causes air to flow through the air inlet of the device. The puff-detection mechanism detects that the air flow rate through the air inlet has increased to greater than a non-zero threshold flow rate. The puff-detection mechanism sends a signal to the controller 206 accordingly. The controller 206 then controls the battery 204 so as to pass an alternating current through the inductor coil 208. This causes the inductor coil 208 to generate a fluctuating electromagnetic field. The rod 13 of combined aerosol-forming substrate is located within this fluctuating electromagnetic field. The materials of the particles 45, graphite and expanded graphite, are susceptor materials. Thus, the fluctuating electromagnetic field causes eddy currents in the particles 45. This causes the particles 45 to heat up, thereby also heating nearby aerosol-forming material.

Heating of the aerosol-forming material cause the aerosol-forming material to release volatile compounds. These compounds are entrained by the air flowing from the upstream end

18 of the article 11 towards the downstream end 20 of the article 11. The compounds cool and condense to form an aerosol as they pass through the internal cavities 28, 36 of the support element and the aerosol-cooling element. The aerosol then passes through the mouthpiece element 42, which may filter out unwanted particles entrained in the air flow, and into the mouth of the user.

When the user stops inhaling on the article 11, the air flow rate through the air inlet of the device decreases to less than the non-zero threshold flow rate. This is detected by the puff-detection mechanism. The puff-detection mechanism sends a signal to the controller 206 accordingly. The controller 206 then controls the battery 204 so as to reduce the current being passed through the electrically resistive track to zero.

After a number of puffs on the article 11, the user may choose to replace the article 11 with a fresh article.

Figure 5 shows a schematic cross-sectional view of a third embodiment of an aerosol-generating article 510. This third embodiment is identical to the first embodiment of Figure 1 except that the rod 12 of aerosol-forming substrate has been replaced by an alternative rod 512 of aerosol-forming substrate. Identical reference numerals have been used for identical components in the embodiments of Figures 1 and 5.

The rod 512 of aerosol-forming substrate of the third embodiment of Figure 5 includes an elongate susceptor element 580.

The susceptor element 580 is arranged substantially longitudinally within the rod 512 of aerosol-forming substrate so as to be approximately parallel with a longitudinal axis of the rod 512 of aerosol-forming substrate. As shown in the drawing of Figure 5, the susceptor element 580 is positioned in a radially central position within the rod and extends along the longitudinal axis of the rod 12.

The susceptor element 580 extends all the way from an upstream end to a downstream end of the rod 512 of aerosol-forming substrate. As such, the susceptor element 580 has substantially the same length as the rod 512 of aerosol-forming substrate.

In the embodiment of Figure 5, the susceptor element 580 is provided in the form of a strip of a ferromagnetic steel and has a length of about 12 millimetres, a thickness of about 60 micrometres, and a width of about 4 millimetres.

The aerosol-generating article 510 of Figure 5 may be used with the aerosol-generating device 202 of Figure 4 in the same way as the aerosol-generating article 11 of Figure 2. Notably, the inclusion of the susceptor element 580 means that the article 510 may be inductively heated regardless of whether the thermally conductive particles comprise a suitable susceptor material for inductive heating.

The rod 512 of aerosol-forming substrate comprises, on a dry weight basis, around 66 wt % thermally conductive particles 44. In this embodiment, the thermally conductive particles 44 are graphite particles, specifically commercially available FP 99,5 (>99.5% purity) graphite particles from Graphit Kropfmül GmbH, AMG Graphite GK, though other particles or mixtures of particles could be used. Each thermally conductive particle has a thermal conductivity of around 6 W/(mK) in at least one direction at 25 degrees Celsius.

The rod 512 of aerosol-forming substrate comprises, on a dry weight basis, around 20 wt % of an aerosol former. In this embodiment, the aerosol former is glycerol, specifically commercially available ICOF Europe fodd grade (>99.5% purity) glycerol.

The rod 512 of aerosol-forming substrate comprises, on a dry weight basis, around 7 wt % of fibres. In this embodiment, the fibres are cellulose fibres, specifically commercially available Birch cellulose fibers from Stora Enso OYJ.

The rod 512 of aerosol-forming substrate comprises, on a dry weight basis, around 4 wt % of a binder. In this embodiment, the binder is a Sodium Carboxymethyl cellulose, specifically commercially available Sodium Carboxymethyl cellulose (CMC) Type K-700 from GumixInternational Inc.

The rod 512 of aerosol-forming substrate comprises, on a dry weight basis, around 1 wt % nicotine.

The rod 512 of aerosol-forming substrate comprises, on a dry weight basis, around 2 wt % of an acid. In this embodiment, the acid is fumaric acid, specifically a commercially available fumaric acid from Sigma-Aldrich (>99% purity).

In other embodiments, the substrate further includes at least one botanical, for example clove or Rosmarinus.

The rod 12 of aerosol-forming substrate comprises about 10 wt % water, when measured at 25 degrees Celsius.

The aerosol-forming substrate has a thermal conductivity of at least 0.1 W/(mK) in at least one direction at 25 degrees Celsius. The aerosol-forming substrate may have a thermal conductivity of 0.2, 0.5, 1, 1.5 or greater W/(mK) in at least one direction at 25 degrees Celsius

The thermally conductive particles 44 are identical to those in the rod 12 of the first embodiment of Figure 1.

The rod 512 of aerosol-forming substrate is formed by the process set out below.

A slurry is formed using a lab disperser capable of mixing viscous liquids, dispersing powders through liquids, and removing gas from a mixture (for example by applying a vacuum or other suitably low pressure). In this embodiment, a commercially available lab disperser from PC Laborsystem was used.

To form the slurry, a first mixture is formed by adding to the lap disperser around 12 grams of a solution of nicotine in glycerine (the aerosol former) at a concentration of 10%, then around 13.2 grams of glycerine, then around 2.4 grams of fumaric acid, then around 280 grams of water, then around 8.4 grams of the fibres. Then, these first ingredients are mixed at 25 degrees Celsius for 5 minutes at 600-700 rpm to ensure a homogeneous mixture and to hydrate the fibers. Then, a second mixture is formed by manually mixing around 79.2 grams of the thermally conductive particles and around 4.8 grams of the binder. This mixing of the second mixture avoids the formation of lumps in the lab dispersion. Then, the second mixture is added to the first mixture to form a combined mixture. Then, the combined mixture is mixed at 5000 rpm for 4 minutes at 25 degrees Celsius and a first reduced pressure of around 200 mbar. The reduced pressure may help to ensure that the thermally conductive particles are homogeneously dispersed in the mixture and that there is little trapped air and few lumps in the combined mixture. Then, the combined mixture is mixed at 5000 rpm for 20 second minutes at 25 degrees Celsius and a second reduced pressure of around 100 mbar. This second reduced pressure may help to remove any remaining air bubbles. This forms a slurry for casting.

The slurry is then casted and dried using a suitable apparatus. In this embodiment, a commercially available Labcoater Mathis apparatus is used. This apparatus includes a stainless steel, flat support, and a coma blade for adjusting a thickness of slurry cast onto the flat support.

The slurry is cast onto the flat support and a gap between the coma blade and the flat support is set at 0.6 millimetres. This ensures that a thickness of the slurry is no more than 0.6 millimetres at any given point.

The slurry is then dried with hot air between 120 and 140 degrees Celsius for between 2 and 5 minutes. After this drying, a sheet of the aerosol-forming substrate is formed. This sheet has a thickness of around 230 microns, and a grammage of around 200 grams per metre squared.

The sheet is then gathered and cut to form a substantially rod-shaped precursor. Then the susceptor element inserted into the precursor to form the rod 512 of aerosol-forming substrate.

After forming the rod 512 of aerosol-forming substrate, the aerosol-generating article 510 is assembled by positioning the various components of the article 510 and wrapping the components in the wrapper 70.

For the purpose of the present description and of the appended claims, except where otherwise indicated, all numbers expressing amounts, quantities, percentages, and so forth, are to be understood as being modified in all instances by the term "about". Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein. In this context, therefore, a number A is understood as A ± 10% of A. Within this context, a number A may be considered to include numerical values that are within general standard error for the measurement of the property that the number A modifies. The number A, in some instances as used in the appended claims, may deviate by the percentages enumerated above provided that the amount by which A deviates does not materially affect the basic and novel characteristic(s) of the claimed invention. Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein.

CLAIMS

1. An aerosol-forming substrate comprising, on a dry weight basis:
    between 10 and 90 wt % carbon particles;
    between 7 and 60 wt % of an aerosol former;
    between 2 and 20 wt % of fibres; and
    between 2 and 10 wt % of a binder,

   wherein each of the carbon particles consists of one or more of graphite, expanded graphite, graphene, carbon nanotubes, charcoal, and diamond.

2. An aerosol-forming substrate according to claim 1, wherein the carbon particles have a particle size distribution having a volume D10 particle size between 1 and 20 microns
3. An aerosol-forming substrate according to claim 1 or 2, wherein the carbon particles have a particle size distribution having a volume D90 particle size between 50 and 300 microns.
4. An aerosol-forming substrate according to any preceding claim, wherein the carbon particles have a particle size distribution having a volume D10 particle size and a number D90 particle size, wherein the volume D90 particle size is no more than 50 times the number D10 particle size.
5. An aerosol-forming substrate according to any preceding claim, wherein some or all of the carbon particles are substantially spherical.
6. An aerosol-forming substrate according to any preceding claim, wherein each of the carbon particles consists of one or more of expanded graphite, graphene, and diamond.
7. An aerosol-forming substrate according to any preceding claim, wherein the substrate comprises, on a dry weight basis, at least 40 wt % of the carbon particles.
8. An aerosol-forming substrate according to any preceding claim, wherein the substrate comprises, on a dry weight basis, at least 60 wt % of the carbon particles.
9. An aerosol-forming substrate according to any preceding claim, wherein the carbon particles are substantially homogeneously distributed throughout the aerosol-forming substrate.
10. An aerosol-forming substrate according to any preceding claim, wherein the aerosol-forming substrate is a tobacco-free aerosol-forming substrate.
11. An aerosol-forming substrate according to any preceding claim, wherein the aerosol-forming substrate comprises between 1 and 20 wt % water.
12. A combined aerosol-forming substrate comprising:

    a first material and a second material, the first material being comprised in the combined aerosol-forming substrate as a first plurality of discrete elements and the second material being comprised in the combined aerosol-forming substrate as a second plurality of discrete elements, in which the first material comprises an aerosol former and has a first thermal conductivity, and in which the second material comprises, or is, an aerosol-forming substrate according to any preceding claim and has a second thermal conductivity that is greater than the first thermal conductivity.

13. An aerosol-generating article comprising an aerosol-forming substrate according to any of claims 1 to 11 or a combined aerosol-forming substrate according to claim 12.

14. An aerosol-generating system comprising an aerosol-generating article according to claim 13 and an electrical aerosol-generating device for heating the aerosol-forming substrate or combined aerosol-forming substrate of the aerosol-generating article.

15. A method of forming an aerosol-forming substrate according to any of claims 1 to 11 or a combined aerosol-forming substrate according to claim 12, the method comprising:

forming a slurry comprising the carbon particles, the aerosol former, the fibres, and the binder; and

casting and drying the slurry to form the aerosol-forming substrate or a precursor for forming into the aerosol-forming substrate.

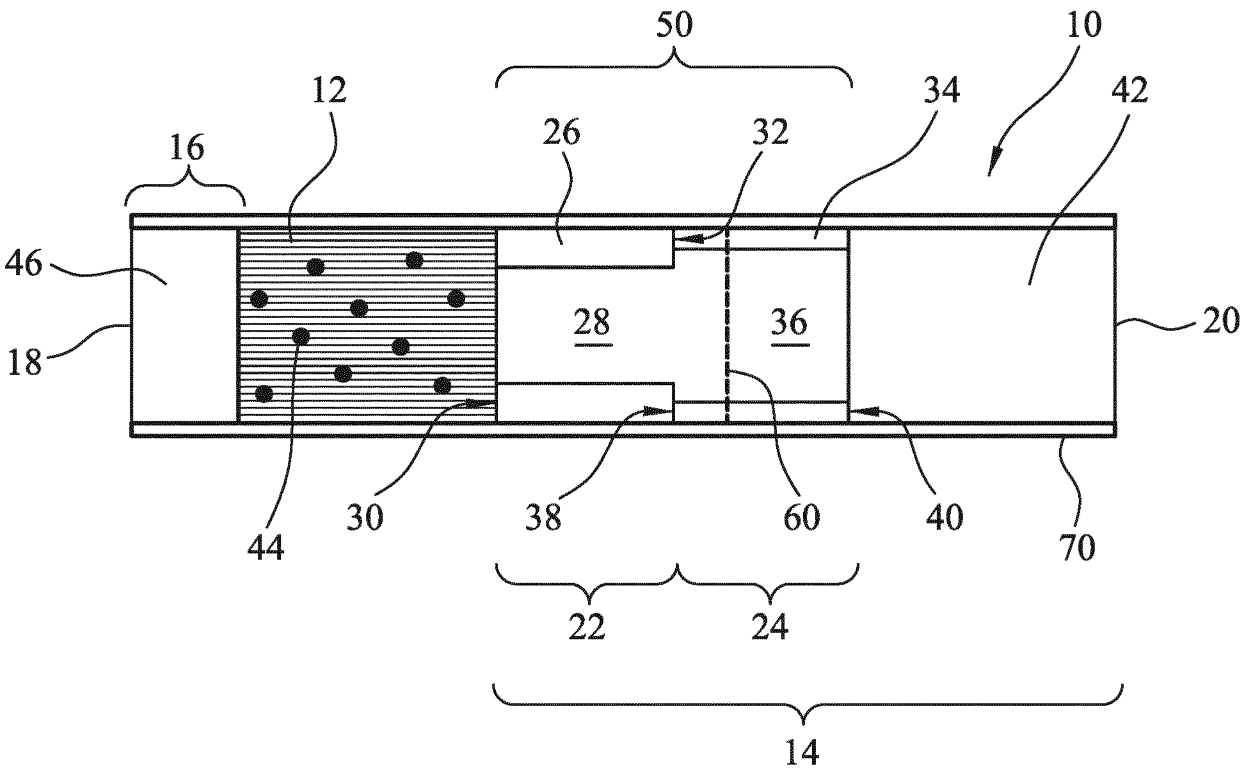

Figure 1

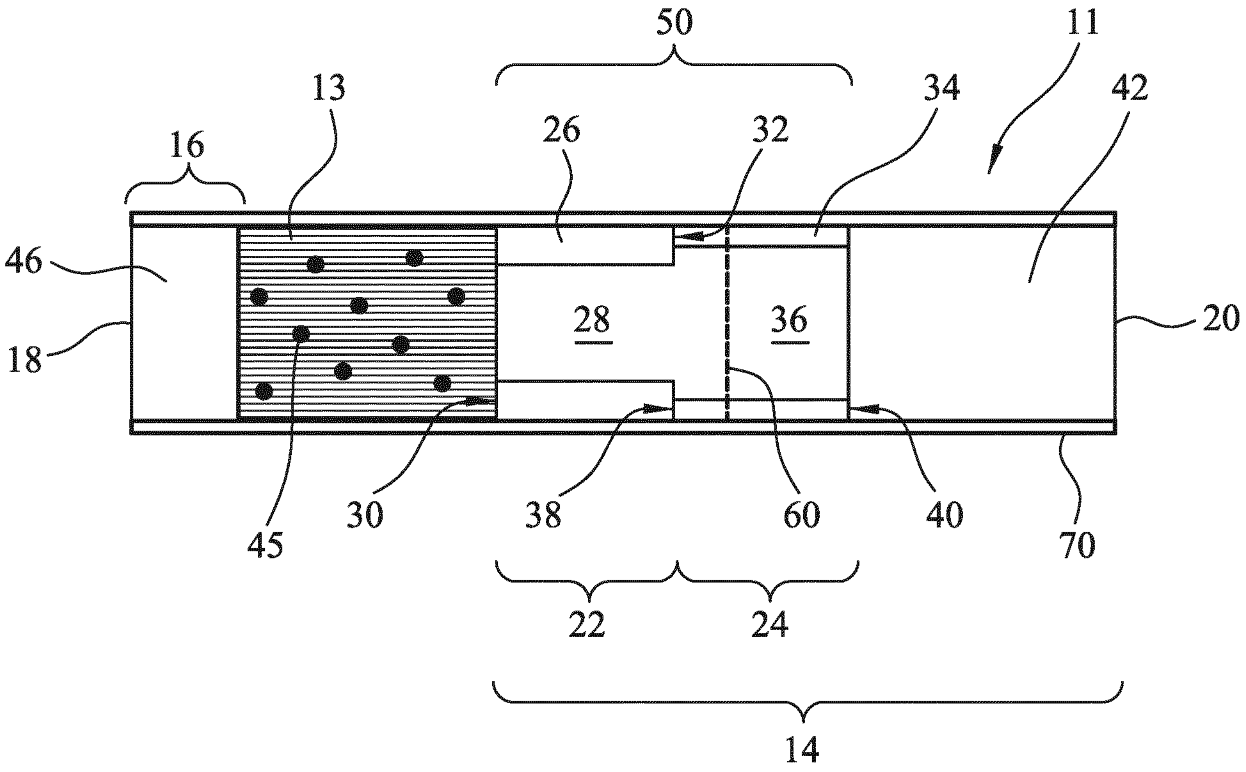

Figure 2

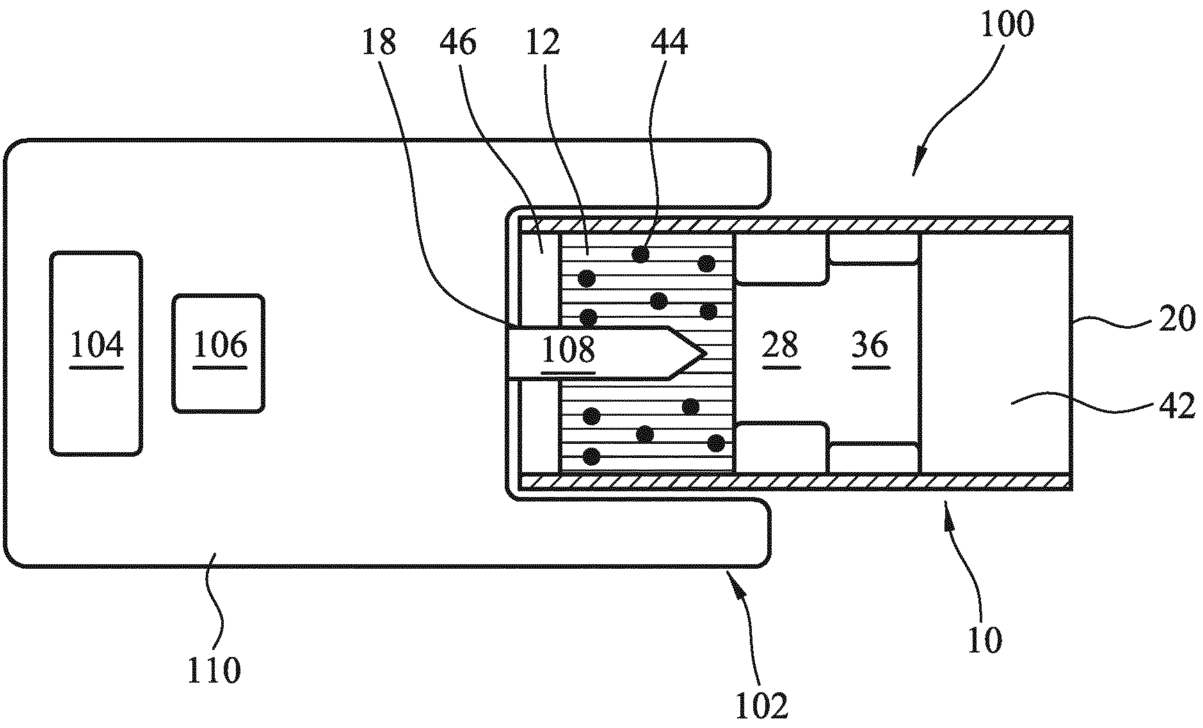

Figure 3

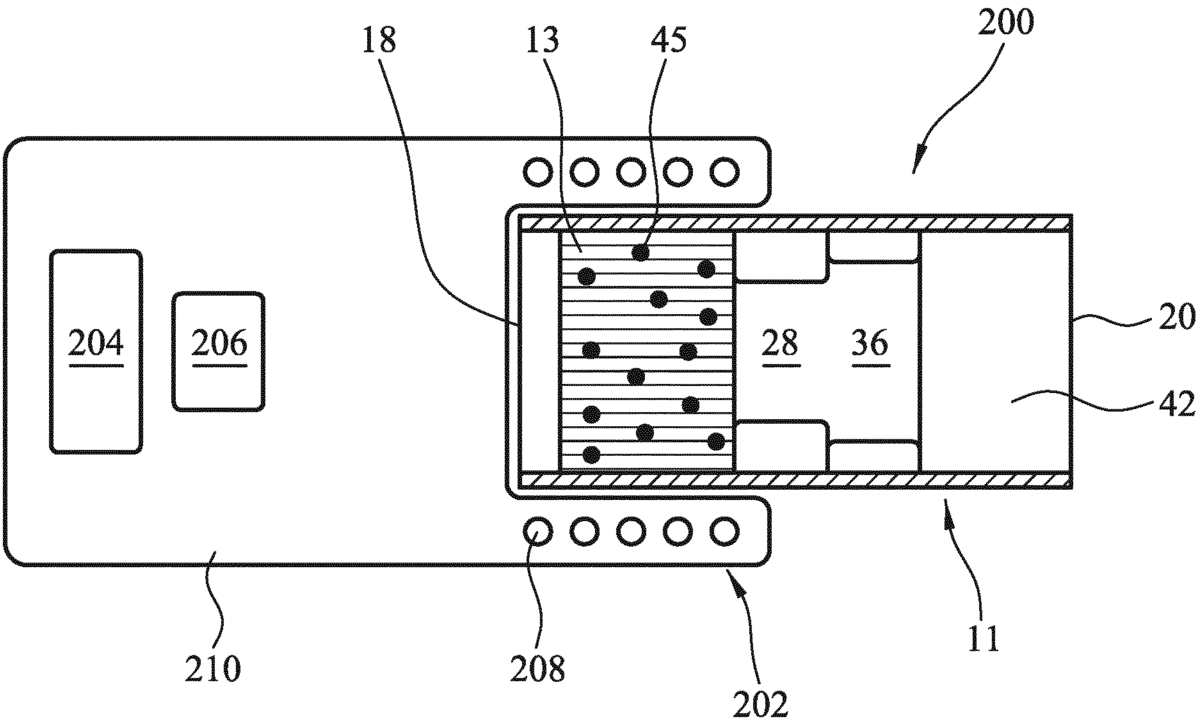

Figure 4

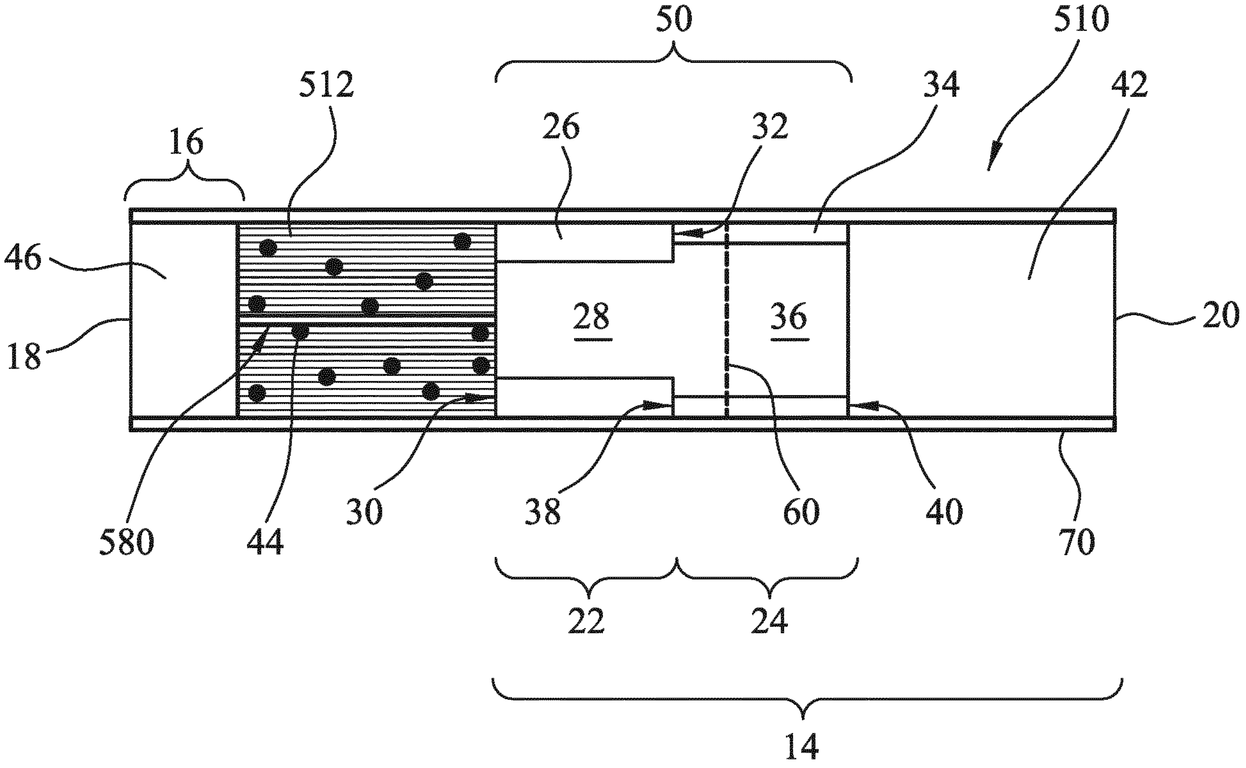

Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/068945

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24B15/14 A24B15/16 A24B15/28 A24B15/42 A24D1/20
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A24B A24F A24D

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

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

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A	paragraph [0001] paragraph [0009] paragraph [0011] - paragraph [0012] paragraph [0014] paragraph [0077] paragraph [0081] paragraph [0111] paragraph [0170] - paragraph [0177] examples 1, 2c, 2d -----	10,12-14
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search 7 September 2022	Date of mailing of the international search report 23/09/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Dimoula, Kerasina

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