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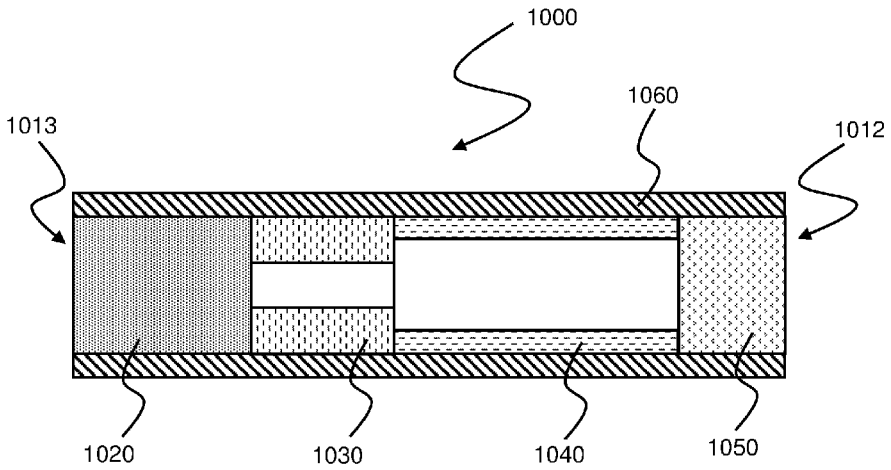

Figure 1

(57) Abstract: There is provided an aerosol-forming substrate (1020) for use in an aerosol generating system. The aerosol-forming substrate is a solid unitary body and comprises a first particulate material and a second particulate material. The first particulate material is formed from particles having a D50 size of between 2 micrometres and 20 micrometres. The second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres. There is also provided an aerosol generating article comprising an aerosol-forming substrate.

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AEROSOL-FORMING SUBSTRATE IN THE FORM OF SOLID UNITARY BODY FROM TWO PARTICULATE MATERIALS

The present invention relates to an aerosol-forming substrate. In particular, the present invention relates to an aerosol-forming substrate for use in an aerosol generating system, the aerosol-forming substrate comprising a first particulate material and a second particulate material, and a process for manufacturing such an aerosol-forming substrate.

Aerosol generating systems for delivering an aerosol to a user typically comprise an atomiser configured to generate an inhalable aerosol from an aerosol-forming substrate. Some known aerosol generating systems comprise a thermal atomiser such as an electric heater or an inductive heating device. The thermal atomiser is configured to heat and vaporise the aerosol-forming substrate to generate an aerosol. Typical aerosol-forming substrates for use in aerosol generating systems are nicotine formulations, which may be liquid nicotine formulations comprising an aerosol former such as glycerine and propylene glycol. Alternatively, aerosol-forming substrates for use in aerosol generating systems may comprise solid components. For example, aerosol-forming substrates may comprise particulate material having a certain size.

However, it has been found that solid aerosol-forming substrates comprising particulate material may be difficult to handle during manufacturing due to agglomerations of the particulate material. In addition, aerosol-forming substrates comprising solid particulate formed into sheets may exhibit defects such as stretch marks and slits. It has also been found that such aerosol-forming substrates may not provide delivery of aerosol for the whole duration of the user experience of the aerosol-forming substrate.

It would be desirable to provide an aerosol-forming substrate which is straightforward to handle during manufacturing and which does not exhibit the defects observed in the prior art. It would also be desirable to provide an aerosol-forming substrate which provides acceptable delivery of an aerosol over the whole duration of the user experience of the aerosol-forming substrate.

The present disclosure relates to an aerosol-forming substrate for use in an aerosol generating system. The aerosol-forming substrate may be a solid unitary body. The aerosol-forming substrate may comprise a first particulate material. The aerosol-forming substrate may comprise a second particulate material. The first particulate material may be formed from particles having a D50 size of between 2 micrometres and 20 micrometres. The second particulate material may be formed from particles having a D50 size of between 50 micrometres and 80 micrometres.

According to the present invention, there is provided an aerosol-forming substrate for use in an aerosol generating system. The substrate comprising a first particulate material, a second particulate material, the first particulate material being formed from particles having a D50 size of

between 2 micrometres and 20 micrometres, and the second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres.

According to the present invention, there is provided an aerosol-forming substrate for use in an aerosol generating system wherein the aerosol-forming substrate is a solid unitary body and comprises: a first particulate material, and a second particulate material, the first particulate material being formed from particles having a D50 size of between 2 micrometres and 20 micrometres, and the second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres.

As used herein with reference to the present invention, the term "solid unitary body" refers to an aerosol-forming substrate comprising the first particulate material and the second particulate material held together in a single solid agglomeration.

According to the present invention, there is also provided a process for manufacturing an aerosol-forming substrate, the process comprising: providing a first particulate material, the first particulate material being formed from particles having a D50 size of between 2 micrometres and 20 micrometres; providing a second particulate material, the second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres; mixing the first particulate material and the second particulate in an aqueous solution to form a slurry; casting the slurry; and drying the cast slurry to form a solid substrate.

The inventors of the present invention have identified that an aerosol-forming substrate comprising particles having a D50 size of between 2 micrometres and 20 micrometres, or 'small' particles, may disadvantageously exhibit agglomeration during manufacturing and processing. In addition, where the aerosol-forming substrate is formed as a thin sheet, the sheet may exhibit defects including stretch marks and slits. However, aerosol-forming substrates comprising particles having a D50 size between 2 micrometres and 20 micrometres result in high density aerosol-forming substrates. This may advantageously provide enhanced aerosol generation over the whole duration of the user experience of the aerosol-forming substrate.

On the other hand, the inventors of the present invention have identified that an aerosol-forming substrate comprising particles having a D50 size of between 50 micrometres and 80 micrometres, or 'large' particles, may advantageously be more straightforward to handle during manufacture and processing since the particles do not exhibit agglomeration to the same extent. In addition, where the aerosol-forming substrate is formed as a sheet, the sheet may be less likely to exhibit defects, allowing the particles to be more readily formed into a thin sheet. However, aerosol-forming substrates comprising particles having a D50 size of between 50 micrometres and 80 micrometres result in lower density aerosol-forming substrates which exhibit a drop or fading of aerosol delivery over the experience of the aerosol-forming substrate.

By providing an aerosol-forming substrate comprising a first particulate material comprising particles having a D50 size between 2 micrometres and 20 micrometres, and a second particulate material comprising particles having a D50 size of between 50 micrometres and 80 micrometres, the inventors have found that the advantageous properties of both particle sizes may be realised. At the same time, the disadvantageous properties of each particle size may be mitigated.

In other words, the inventors have found that the provision of an aerosol-forming substrate comprising a first particulate material being formed from particles having a D50 size of between 2 micrometres and 20 micrometres, and a second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres may advantageously be straightforward to handle during manufacturing and processing and may exhibit good aerosol generation over the whole duration of the user experience of the aerosol-forming substrate.

As used herein with reference to the present invention, the term "D50 size" refers to the median particle size of the particulate material. The D50 size is the particle size which splits the distribution in half, where half of the particles are larger than the D50 size and half of the particles are smaller than the D50 size. The particle size distribution may be determined by laser diffraction. For example, the particle size distribution may be determined by laser diffraction using a Malvern Mastersizer 3000 laser diffraction particle size analyser in accordance with the manufacturer's instructions.

In use, the aerosol-forming substrate may form part of an aerosol generating article which may be inserted into an aerosol generating device. The aerosol generating device may include a heater which heats the aerosol-forming substrate to release an aerosol which may be delivered to a user. The aerosol-forming substrate may release an aerosol when it is heated to at least about 100 degrees Celsius, at least about 200 degrees Celsius, at least about 250 degrees Celsius, at least about 350 degrees Celsius, or at least about 500 degrees Celsius. For example, the aerosol-forming substrate may release an aerosol when it is heated to between about 100 degrees Celsius and about 850 degrees Celsius, between about 200 degrees Celsius and about 600 degrees Celsius, or between about 250 degrees Celsius about 400 degrees Celsius. For example, the aerosol-forming substrate may release an aerosol when it is heated to about 260 degrees Celsius.

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

The second particulate material may be formed from particles having a D50 size which is at least 10 micrometres greater than the D50 size of the first particulate material. For example, the second particulate material may be formed from particles having a D50 size which is at least 10 micrometres greater, 15 micrometres greater, 20 micrometres greater, 30 micrometres greater, 40 micrometres greater, or 50 micrometres greater than the D50 size of the first particulate material.

The second particulate material may be formed from particles having a D50 size which is no more than 100 micrometres greater than the D50 size of the first particulate material. For example, the second particulate material may be formed from particles having a D50 size which is no more than 90 micrometres greater, 80 micrometres greater, 70 micrometres greater, 60 micrometres greater, 55 micrometres greater, or 50 micrometres greater than the D50 size of the first particulate material.

The first particulate material and the second particulate material may be bonded together using a binder to form the aerosol-forming substrate.

The first particulate material and the second particulate material may be bonded together using pressure to form the aerosol-forming substrate.

The first particulate material and the second particulate material may be bonded together using a pressing process, an extrusion process or a cast process.

The aerosol-forming substrate may have a large surface area.

The aerosol-forming substrate may be a sheet, a strip, a rod or a pellet.

The aerosol-forming substrate may be manufactured by any method. The aerosol-forming substrate may be manufactured using a pressing process. The aerosol-forming substrate may be manufactured using an extrusion process. The aerosol-forming substrate may be manufactured using a cast process. The process may include steps of forming a slurry of the first and second particulate materials in an aqueous solution. The aqueous solution may further comprise a binder. The slurry may then be cast, for example using a continuous casting process. The cast slurry may then be dried to form a solid unitary body comprising the first particulate material and the second particulate material. The cast slurry may be dried to form a solid unitary body having any desired geometry through use of an appropriate mould. In some examples, the cast slurry may be dried to form a sheet. The sheet may be crimped and folded to form the finished aerosol-forming substrate. In some examples, the sheet may be over-crimped to sever the sheet into a plurality of strips. In other examples, the cast slurry may be dried to form a strip, a rod or a pellet.

The aerosol-forming substrate may include any proportion of the first particulate material and the second particulate material. The ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be greater than 1.

In other words, by mass, the aerosol-forming substrate may comprise more of the first particulate material than the second particulate material.

The ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be no more than 1. In other words, by mass, the aerosol-forming substrate may comprise more of the second particulate material than the first particulate material.

The ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be no more than 5:1. For example, the ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be no more than 3:1, no more than 1.

The ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be no more than 1:2. In other words, by mass, there is at least twice as much of the second particulate material as the first particulate material.

The inventors have found that where more than one third by mass of the particulate material in the aerosol-forming substrate comprises the first particulate material, being formed from particles having a D50 size of between 2 micrometres and 20 micrometres, the aerosol-forming substrate may exhibit defects such as cracking or slits.

The ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be at least 1:10. For example, the ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be at least 1:8, at least 1:5, or at least 1:3.

The ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be between 1:10 and 5:1, between 1:8 and 3:1, between 1:5 and 1, between 1:5 and 1:2, between 1:3 and 1:2. The ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate may be about 1:2.

The aerosol-forming substrate may have a first particulate material content of greater than 1 weight percent.

As used herein with reference to the invention, all weight percentages are given on a dry weight basis.

The aerosol-forming substrate may have a first particulate material content of greater than 5 weight percent, greater than 8 weight percent, greater than 10 weight percent, or greater than 13 weight percent.

The aerosol-forming substrate may have a first particulate material content of no more than 30 weight percent. For example, the aerosol-forming substrate may have a first particulate

material content of no more than 25 weight percent, no more than 20 weight percent, or no more than 17 weight percent.

The aerosol-forming substrate may have a first particulate material content of between 5 weight percent and 30 weight percent. For example, the aerosol-forming substrate may have a first particulate material content of between 5 weight percent and 25 weight percent, between 5 weight percent and 20 weight percent, or between 5 weight percent and 17 weight percent.

The aerosol-forming substrate may have a first particulate material content of between 8 weight percent and 30 weight percent. For example, the aerosol-forming substrate may have a first particulate material content of between 10 weight percent and 30 weight percent, or between 13 weight percent and 30 weight percent.

The aerosol-forming substrate may have a first particulate material content of between 8 weight percent and 25 weight percent. For example, the aerosol-forming substrate may have a first particulate material content of between 10 weight percent and 20 weight percent, or between 13 weight percent and 17 weight percent.

The aerosol-forming substrate may have a first particulate material content of about 15 weight percent.

The aerosol-forming substrate may have a second particulate material content of greater than 2 weight percent.

The aerosol-forming substrate may have a second particulate material content of greater than 10 weight percent, greater than 16 weight percent, greater than 20 weight percent, or greater than 26 weight percent.

The aerosol-forming substrate may have a second particulate material content of no more than 60 weight percent. For example, the aerosol-forming substrate may have a second particulate material content of no more than 50 weight percent, no more than 40 weight percent, or no more than 34 weight percent.

The aerosol-forming substrate may have a second particulate material content of between 10 weight percent and 60 weight percent. For example, the aerosol-forming substrate may have a second particulate material content of between 10 weight percent and 50 weight percent, between 10 weight percent and 40 weight percent, or between 10 weight percent and 34 weight percent.

The aerosol-forming substrate may have a second particulate material content of between 16 weight percent and 60 weight percent. For example, the aerosol-forming substrate may have a second particulate material content of between 20 weight percent and 60 weight percent, or between 26 weight percent and 60 weight percent.

The aerosol-forming substrate may have a second particulate material content of between 20 weight percent and 40 weight percent. For example, the aerosol-forming substrate may have a first particulate material content of between 26 weight percent and 34 weight percent.

The aerosol-forming substrate may have a second particulate material content of about 30 weight percent.

The aerosol-forming substrate may further comprise one or more aerosol formers.

The provision of one or more aerosol formers advantageously helps the aerosol-forming substrate to generate an aerosol when the aerosol-forming substrate is heated.

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

The aerosol-forming substrate may have an aerosol former content of greater than 0.5 weight percent. The aerosol-forming substrate may have an aerosol former content of greater than 10 weight percent. The aerosol-forming substrate may have an aerosol former content of greater than 20 weight percent weight percent. The aerosol-forming substrate may have an aerosol former content of greater than 30 weight percent. The aerosol-forming substrate may have an aerosol former content of greater than 40 weight percent.

The aerosol-forming substrate may have an aerosol former content of no more than 80 weight percent. The aerosol-forming substrate may have an aerosol former content of no more than 70 weight percent. The aerosol-forming substrate may have an aerosol former content of no more than 60 weight percent. The aerosol-forming substrate may have an aerosol former content of no more than 50 weight percent. The aerosol-forming substrate may have an aerosol former content of no more than 42 weight percent.

In some instances, it has been found that aerosol-forming substrates having an aerosol former content of more than about 42 weight percent were difficult to manufacture.

The first particulate material may be formed from particles having a D50 size of between 2 micrometres and 20 micrometres, between 5 micrometres and 20 micrometres, between 10 micrometres and 20 micrometres, or between 15 micrometres and 20 micrometres.

The first particulate material may be formed from particles having a D50 size of between 2 micrometres and 15 micrometres, between 2 micrometres and 10 micrometres, or between 2 micrometres and 5 micrometres.

The first particulate material may be formed from particles having a D50 size of between 5 micrometres and 15 micrometres. The first particulate material may be formed from particles having a D50 size of about 10 micrometres.

The second particulate material may be formed from particles having a D50 size of between 50 micrometres and 80 micrometres, between 60 micrometres and 80 micrometres, between 70 micrometres and 80 micrometres, or between 75 micrometres and 80 micrometres.

The second particulate material may be formed from particles having a D50 size of between 50 micrometres and 75 micrometres, between 50 micrometres and 70 micrometres, or between 50 micrometres and 60 micrometres.

The second particulate material may be formed from particles having a D50 size of between 55 micrometres and 65 micrometres. The second particulate material may be formed from particles having a D50 size of about 59 micrometres.

The first particulate material may be formed from particles having a D50 size of 10 micrometres, and the second particulate material may be formed from particles having a D50 size of 59 micrometres.

It has been found that the provision of an aerosol-forming substrate comprising a first particulate material and a second particulate material having these D50 sizes may advantageously exhibit both improved handling during manufacture, as well as good delivery of aerosol during use.

The first particulate material may be formed from particles having a D95 size of at least 10 micrometres.

As used herein with reference to the present invention, the term “D95 size” is the size at which the proportion by mass of particles with sizes below this value is 95 percent.

The first particulate material may be formed from particles having a D95 size of at least 15 micrometres, at least 20 micrometres, or at least 30 micrometres.

The first particulate material may be formed from particles having a D95 size of no more than 60 micrometres, no more than 50 micrometres, or no more than 40 micrometres.

The first particulate material may be formed from particles having a D95 between 10 micrometres and 60 micrometres, between 15 micrometres and 50 micrometres, between 20 micrometres and 40 micrometres, or between 30 micrometres and 40 micrometres.

The second particulate material may be formed from particles having a D95 size of at least 80 micrometres.

The second particulate material may be formed from particles having a D95 size of at least 90 micrometres, at least 100 micrometres, or at least 110 micrometres.

The second particulate material may be formed from particles having a D95 size of no more than 130 micrometres, no more than 125 micrometres, or no more than 120 micrometres.

The second particulate material may be formed from particles having a D95 between 80 micrometres and 130 micrometres, between 90 micrometres and 125 micrometres, between 100 micrometres and 120 micrometres, or between 110 micrometres and 120 micrometres.

The first particulate material may be formed from particles having a D95 size of 33 micrometres. The second particulate material may be formed from particles having a D95 size of 116 micrometres.

The second particulate material may be formed from particles having a D95 size which is at least 40 micrometres greater than the D95 size of the first particulate material. For example, the second particulate material may be formed from particles having a D95 size which is at least 50 micrometres greater, 60 micrometres greater, 70 micrometres greater, or 80 micrometres greater than the D95 size of the first particulate material.

The second particulate material may be formed from particles having a D95 size which is no more than 200 micrometres greater than the D95 size of the first particulate material. For example, the second particulate material may be formed from particles having a D95 size which is no more than 180 micrometres greater, 150 micrometres greater, 120 micrometres greater, 100 micrometres greater, 90 micrometres greater, or 80 micrometres greater than the D95 size of the first particulate material.

The first particulate material may be formed from particles having a diameter of at least 5 micrometres. For example, the first particulate material may be formed from particles having a diameter of at least 10 micrometres, at least 20 micrometres, or at least 30 micrometres.

As used herein with reference to the present invention, the term “diameter” refers to a straight line distance between two points on the surface of a particle. Where the straight line distance between the two most distant points on the surface of a particle is 5 micrometres, it will be understood the particle has a diameter of at least 5 micrometres. Use of the term “diameter” does not imply that the particles being characterized are spherical. Where the particle is a fibre, the “diameter” will correspond to the length of the fibre.

The first particulate material may be formed from particles having a diameter of no more than 40 micrometres. For example, the first particulate material may be formed from particles having a diameter of no more than 50 micrometres, no more than 40 micrometres, or no more than 35 micrometres.

The first particulate material may be formed from particles having a diameter between 5 micrometres and 40 micrometres, between 10 micrometres and 35 micrometres, or between 20 micrometres and 30 micrometres.

The second particulate material may be formed from particles having a diameter of at least 50 micrometres. For example, the second particulate material may be formed from particles having a diameter of at least 80 micrometres, at least 100 micrometres, or at least 125 micrometres.

The second particulate material may be formed from particles having a diameter of no more than 250 micrometres. For example, the second particulate material may be formed from

particles having a diameter of no more than 225 micrometres, no more than 200 micrometres, or no more than 150 micrometres.

The second particulate material may be formed from particles having a diameter between 50 micrometres and 250 micrometres, between 80 micrometres and 225 micrometres, or between 100 micrometres and 125 micrometres.

The first particulate material may be formed from particles having a diameter between 5 micrometres and 40 micrometres, and the second particulate material may be formed from particles having a diameter of between 50 micrometres and 250 micrometres.

The first particulate material and the second particulate material may be formed from different materials.

The first particulate material and the second particulate material may be formed from the same material.

At least one of the first particulate material and the second particulate material may comprise one or more of cellulose and microcrystalline cellulose (MCC).

The first particulate material may comprise cellulose. The first particulate material may comprise microcrystalline cellulose. The second particulate material may comprise cellulose. The second particulate material may comprise microcrystalline cellulose.

The cellulose or microcrystalline cellulose may advantageously increase the tensile strength of the aerosol-forming substrate.

Both the first particulate material and the second particulate material may comprise one or more of cellulose and microcrystalline cellulose (MCC).

The particles of the first and second particulate materials may be fibres. Where this is the case, the first particulate material may be a first fibrous material and the second particulate material may be a second fibrous material.

The particles of the first particulate material and the second particulate material may form a bimodal size distribution, wherein a first peak of the bimodal size distribution corresponds to the first particulate material and a second peak of the bimodal size distribution corresponds to the second particulate material.

As used herein with reference to the present invention, a “bimodal size distribution” refers to a particle size frequency distribution with two different modes or peaks. The first peak corresponds to the first particulate material and the second peak corresponds to the second particulate material.

The aerosol-forming substrate may be a strip.

The aerosol-forming substrate may be a rod.

The aerosol-forming substrate may be a pellet.

The aerosol-forming substrate may be a sheet.

As used herein with reference to the present invention, the term “sheet” denotes a laminar element having a width and length substantially greater than the thickness thereof.

The sheet may be a gathered sheet. As used herein with reference to the invention, the term “gathered” denotes that the sheet is convoluted, folded, or otherwise compressed or constricted. The sheet may be folded substantially transversely to a cylindrical axis of the aerosol generating article.

Sheets according to the invention do not comprise flowable liquid. Consequently, users of aerosol generating rods and aerosol generating articles according to the invention are advantageously not required to handle liquid formulations.

E-cigarettes typically use a liquid formulation comprising free nicotine base. Nicotine salts may be more stable than free nicotine base. Consequently, aerosol-forming substrate according to the invention may advantageously have longer shelf lives than liquid formulations typical used in e-cigarettes.

The aerosol-forming substrate may further comprise a binder.

Inclusion of a binder may advantageously facilitate manufacture of the aerosol-forming substrate.

Inclusion of a binder may advantageously improve the homogeneity of the aerosol-forming substrate compared to an aerosol-forming substrate in which no binder is included.

The aerosol-forming substrate may comprise a gum binder.

The aerosol-forming substrate may comprise a natural gum binder. The aerosol-forming substrate may comprise one or more natural gum binders selected from the group consisting of guar gum, xanthan gum, natural gum, and gum arabic.

The aerosol-forming substrate may have a binder content of greater than 1 weight percent. For example, the aerosol-forming substrate may have a binder content of greater than 2 weight percent, or greater than 3 weight percent.

The aerosol-forming substrate may a have a binder content of no more than 10 weight percent. For example, the aerosol-forming substrate may have a binder content of no more than 8 weight percent, or no more than 6 weight percent.

The aerosol-forming substrate may have a binder content of between 1 weight percent and 10 weight percent, between 1 weight percent and 8 weight percent, or between 1 weight percent and 6 weight percent.

The aerosol-forming substrate may have a binder content of between 2 weight percent and 10 weight percent, between 2 weight percent and 8 weight percent, or between 2 weight percent and 6 weight percent.

The aerosol-forming substrate may have a binder content of between 3 weight percent and 10 weight percent, between 3 weight percent and 8 weight percent, or between 3 weight percent and 6 weight percent.

The aerosol-forming substrate may have a binder content of about 5 weight percent.

The binder may comprise carboxymethyl cellulose (CMC).

Advantageously, carboxymethyl cellulose may provide quicker delivery of an aerosol in aerosol-forming substrates comprising CMC. In particular, it has been found that aerosol-forming substrates using CMC as a binder exhibit good aerosol delivery from the first puff comparted to aerosol-forming substrates which use other binders.

The carboxymethyl cellulose may comprise sodium carboxymethyl cellulose. Advantageously, the present inventors have found that sodium carboxymethyl cellulose is a carboxymethyl cellulose that may be particularly effective at providing quick aerosol delivery from early on in the user experience.

The aerosol-forming substrate may comprise nicotine.

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

The nicotine may comprise an extract of tobacco.

The aerosol-forming substrate may have a nicotine content of greater than 0.5 weight percent. For example, the aerosol-forming substrate may have a nicotine content of greater than 1 weight percent, greater than 2 weight percent, greater than 3 weight percent, greater than 5 weight percent, or 8 weight percent.

The aerosol-forming substrate may have a nicotine content of no more than 10 weight percent. For example, the aerosol-forming substrate may have a nicotine content of no more than 8 weight percent, no more than 5 weight percent, no more than 3 weight percent, no more than 2 weight percent, or no more than 1 weight percent.

The aerosol-forming substrate may have a nicotine content of between 0.5 weight percent and 10 weight percent. For example, the aerosol-forming substrate may have a nicotine content of between 0.5 weight percent and 8 weight percent, between 0.5 weight percent and 5 weight percent, between 0.5 weight percent and 3 weight percent, between 0.5 weight percent and 2 weight percent, or between 0.5 weight percent and 1 weight percent.

The aerosol-forming substrate may have a nicotine content of between 1 weight percent and 5 weight percent. For example, the aerosol-forming substrate may have a nicotine content of between 1 weight percent and 3 weight percent, or between 1 weight percent and 2 weight percent. The aerosol-forming substrate may have a nicotine content of about 1.5 weight percent.

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

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

The aerosol-forming substrate may have a carboxylic acid content of greater than 0.5 weight percent. For example, the aerosol-forming substrate may have a carboxylic acid content of greater than 1 weight percent, greater than 2 weight percent, or greater than 3 weight percent.

The aerosol-forming substrate may have a carboxylic acid content of no more than 15 weight percent. For example, the aerosol-forming substrate may have a carboxylic acid content of no more than 10 weight percent, no more than 5 weight percent, or no more than 3 weight percent.

The aerosol-forming substrate may have a carboxylic acid content of between 0.5 weight percent and 15 weight percent. For example, the aerosol-forming substrate may have a carboxylic acid content of between 0.5 weight percent and 10 weight percent, between 0.5 weight percent and 5 weight percent, or between 0.5 weight percent and 3 weight percent.

The aerosol-forming substrate may have a carboxylic acid content of between 2 weight percent and 15 weight percent. For example, the aerosol-forming substrate may have a carboxylic acid content of between 2 weight percent and 10 weight percent, between 2 weight percent and 5 weight percent, or between 2 weight percent and 3 weight percent. The aerosol-forming substrate may have a carboxylic acid content of about 2.5 weight percent. The aerosol-forming substrate may have a lactic acid content of about 2.5 weight percent.

The aerosol-forming substrate may comprise one or more disaccharides such as lactose, sucrose and trehalose, one or more sugar alcohols such as mannitol and sorbitol or a combination of one or more disaccharides and one or more sugar alcohols.

The aerosol-forming substrate may have a disaccharide content of greater than 0.5 weight percent. For example, the aerosol-forming substrate may have a disaccharide content of greater than 1 weight percent, greater than 2 weight percent, or greater than 3 weight percent.

The aerosol-forming substrate may have a disaccharide content of no more than 15 weight percent. For example, the aerosol-forming substrate may have a disaccharide content of no more than 10 weight percent, no more than 8 weight percent, or no more than 5 weight percent.

The aerosol-forming substrate may have a disaccharide content of between 0.5 weight percent and 15 weight percent. For example, the aerosol-forming substrate may have a disaccharide content of between 0.5 weight percent and 10 weight percent, between 0.5 weight percent and 8 weight percent, or between 0.5 weight percent and 5 weight percent.

The aerosol-forming substrate may have a disaccharide content of between 3 weight percent and 15 weight percent. For example, the aerosol-forming substrate may have a disaccharide content of between 3 weight percent and 10 weight percent, or between 3 weight percent and 8 weight percent. The aerosol-forming substrate may have a disaccharide content of about 2.5 weight percent. The aerosol-forming substrate may have a sucrose content of about 2.5 weight percent.

The aerosol-forming substrate may comprise cellulose strengthening fibres.

The cellulose strengthening fibres may have a D50 size of at least 0.2 millimetres, at least 0.5 millimetres, at least 0.7 millimetres, or at least 0.9 millimetres.

The cellulose strengthening fibres may have a D50 size of no more than 2.0 millimetres, no more than 1.8 millimetres, no more than 1.6 millimetres, or no more than 1.4 millimetres.

For example, the cellulose strengthening fibres may have a D50 size of between 0.2 millimetres and 2.0 millimetres, between 0.5 millimetres and 1.8 millimetres, between 0.7 millimetres and 1.6 millimetres, or between 0.9 millimetres and 1.4 millimetres.

The cellulose strengthening fibres may have a D50 size of between 0.2 millimetres and 1.8 millimetres, between 0.2 millimetres and 1.6 millimetres, or between 0.2 millimetres and 1.4 millimetres.

The cellulose strengthening fibres may have a D50 size of between 0.5 millimetres and 2.0 millimetres, between 0.5 millimetres and 1.6 millimetres, or between 0.5 millimetres and 1.4 millimetres.

The cellulose strengthening fibres may have a D50 size of between 0.7 millimetres and 2.0 millimetres, between 0.7 millimetres and 1.8 millimetres, or between 0.7 millimetres and 1.4 millimetres.

Advantageously, the present inventors have found that cellulose fibres may act as a strengthening agent that is particularly effective at increasing the tensile strength of an aerosol-forming substrate. Accordingly, these cellulose fibres may be referred to as cellulose strengthening fibres.

The cellulose strengthening fibres may have a particle diameter of at least 0.2 millimetres, at least 0.5 millimetres, at least 0.7 millimetres, or at least 0.9 millimetres.

The cellulose strengthening fibres may have a particle diameter of no more than 2.0 millimetres, no more than 1.8 millimetres, no more than 1.6 millimetres, or no more than 1.4 millimetres.

For example, the cellulose strengthening fibres may have a particle diameter of between 0.2 millimetres and 2.0 millimetres, between 0.5 millimetres and 1.8 millimetres, between 0.7 millimetres and 1.6 millimetres, or between 0.9 millimetres and 1.4 millimetres.

The cellulose strengthening fibres may have a particle diameter of between 0.2 millimetres and 1.8 millimetres, between 0.2 millimetres and 1.6 millimetres, or between 0.2 millimetres and 1.4 millimetres.

The cellulose strengthening fibres may have a particle diameter of between 0.5 millimetres and 2.0 millimetres, between 0.5 millimetres and 1.6 millimetres, or between 0.5 millimetres and 1.4 millimetres.

The cellulose strengthening fibres may have a particle diameter of between 0.7 millimetres and 2.0 millimetres, between 0.7 millimetres and 1.8 millimetres, or between 0.7 millimetres and 1.4 millimetres.

The aerosol-forming substrate may have a cellulose strengthening fibre content of greater than 0.5 weight percent. For example, the aerosol-forming substrate may have a cellulose strengthening fibre content of greater than 1 weight percent, greater than 2 weight percent, or greater than 3 weight percent.

The aerosol-forming substrate may have a cellulose strengthening fibre content of no more than 15 weight percent. For example, the aerosol-forming substrate may have a cellulose fibre content of no more than 10 weight percent, no more than 8 weight percent, or no more than 5 weight percent.

The aerosol-forming substrate may have a cellulose fibre content of between 0.5 weight percent and 15 weight percent. For example, the aerosol-forming substrate may have a cellulose fibre content of between 0.5 weight percent and 10 weight percent, between 0.5 weight percent and 8 weight percent, or between 0.5 weight percent and 5 weight percent.

The aerosol-forming substrate may have a cellulose fibre content of between 3 weight percent and 15 weight percent. For example, the aerosol-forming substrate may have a cellulose fibre content of between 3 weight percent and 10 weight percent, or between 3 weight percent and 8 weight percent. The aerosol-forming substrate may have a cellulose fibre content of about 6 weight percent.

The aerosol-forming substrate may further comprise one or more of nicotine, lactic acid, and sucrose.

The first particulate material may have any density. The first particulate material may have a density of greater than 0.5 grams per centimetre cubed. For example, the first particulate material may have a density of greater than 1.0 grams per centimetre cubed, greater than 1.5 grams per centimetre cubed, greater than 3.0 grams per centimetre cubed, or greater than 5.0 grams per centimetre cubed.

As set out above, the provision of a first particulate material having a relatively high density may advantageously provide enhanced aerosol generation over the whole duration of the user experience of the aerosol-forming substrate.

The second particulate material may have any density. The second particulate material may have a density of greater than 0.1 grams per centimetre cubed. For example, the first particulate material may have a density of greater than 0.3 grams per centimetre cubed, greater than 0.5 grams per centimetre cubed, or greater than 0.6 grams per centimetre cubed.

The second particulate material may have a density of no more than 2.0 grams per centimetre cubed. For example, the first particulate material may have a density of no more than 1.5 grams per centimetre cubed, no more than 1.0 grams per centimetre cubed, or greater than 0.8 grams per centimetre cubed.

The second particulate material may have a density of between 0.1 grams per centimetre cubed and 2.0 grams per centimetre cubed. For example, the second particulate material may have a density of between 0.3 grams per centimetre cubed and 1.5 grams per centimetre cubed, between 0.5 grams per centimetre cubed and 1.0 grams per centimetre cubed, or between 0.5 grams per centimetre cubed and 0.8 grams per centimetre cubed.

The second particulate material may have a density of between 0.6 grams per centimetre cubed and 0.8 grams per centimetre cubed.

As set out above, the provision of a second particulate material having a relatively low density may advantageously improve the physical properties of the aerosol-forming substrate making it less prone to exhibit defects.

The aerosol-forming substrate may not comprise tobacco.

According to the present invention, there is also provided aerosol generating article comprising an aerosol-forming substrate as described above.

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

The aerosol generating article may include a hollow cellulose acetate tube. The aerosol generating article may include a spacer element. The aerosol generating article may include a mouthpiece filter. The aerosol-forming substrate, the hollow cellulose acetate tube, the spacer element and the mouthpiece filter may be arranged sequentially. The aerosol-forming substrate,

the hollow cellulose acetate tube, the spacer element and the mouthpiece filter may be arranged in a coaxial alignment.

The aerosol generating article may include a cigarette paper.

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

The aerosol generating article may have a mouth-end and a distal end. In use, a user may insert the mouth-end into their mouth.

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

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

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

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 1: An aerosol-forming substrate for use in an aerosol generating system, comprising; a first particulate material, a second particulate material, the first particulate material being formed from particles having a D50 size of between 2 micrometres and 20 micrometres, and the second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres.

Example 1A: An aerosol-forming substrate for use in an aerosol generating system, comprising; a first particulate material, and a second particulate material bound with the first particulate material, the first particulate material being formed from particles having a D50 size of between 2 micrometres and 20 micrometres, and the second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres.

Example 2: An aerosol-forming substrate for use in an aerosol generating system, comprising; a particulate material comprising a plurality of fibres, the plurality of fibres having a size distribution comprising: a first peak corresponding to a D50 value of between 2 micrometres

and 20 micrometres, and a second peak corresponding to a D50 value of between 50 micrometres and 80 micrometres.

Example 3: An aerosol-forming substrate for use in an aerosol generating system, comprising; a first particulate material, a second particulate material, the first particulate material being formed from particles having a D50 size of 10 micrometres, and the second particulate material being formed from particles having a D50 size of 59 micrometres.

Example 4: An aerosol-forming substrate for use in an aerosol generating system, comprising; a first particulate material, a second particulate material, the first particulate material being formed from particles having a D95 size of between 10 micrometres and 60 micrometres, and the second particulate material being formed from particles having a D95 size of between 80 micrometres and 130 micrometres.

Example 5: An aerosol-forming substrate for use in an aerosol generating system, comprising; a first particulate material, a second particulate material, the first particulate material being formed from particles having a D95 size of 33 micrometres, and the second particulate material being formed from particles having a D95 size of 116 micrometres.

Example 6: An aerosol-forming substrate for use in an aerosol generating system, comprising; a first particulate material, a second particulate material, the first particulate material being formed from particles having a diameter of between 5 micrometres and 40 micrometres, and the second particulate material being formed from particles having a diameter of between 50 micrometres and 250 micrometres.

Example 6A: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate is a solid unitary body.

Example 7: An aerosol-forming substrate according to any preceding Example, wherein the ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate is no more than 1:2.

Example 8: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate further comprises one or more aerosol formers.

Example 9: An aerosol-forming substrate according to Example 8, wherein the aerosol former comprises glycerine.

Example 10: An aerosol-forming substrate according to any preceding Example, wherein the first particulate material is formed from particles having a D50 size of 10 micrometres, and the second particulate material is formed from particles having a D50 size of 59 micrometres.

Example 11: An aerosol-forming substrate according to any preceding Example, wherein the first particulate material is formed from particles having a D95 size of between 10 micrometres and 60 micrometres.

Example 12: An aerosol-forming substrate according to any preceding Example, wherein the second particulate material is formed from particles having a D95 size of between 80 micrometres and 130 micrometres.

Example 13: An aerosol-forming substrate according to any preceding Example, wherein the first particulate material is formed from particles having a D95 size of 33 micrometres, and the second particulate material is formed from particles having a D95 size of 116 micrometres.

Example 14: An aerosol-forming substrate according to any preceding Example, wherein the first particulate material is formed from particles having a diameter of between 5 micrometres and 40 micrometres, and the second particulate material being formed from particles having a diameter of between 50 micrometres and 250 micrometres.

Example 15: An aerosol-forming substrate according to any preceding Example, wherein the first particulate material and the second particulate material are formed from different materials.

Example 16: An aerosol-forming substrate according to any of Examples 1 to 14, wherein the first particulate material and the second particulate material are formed from the same material.

Example 17: An aerosol-forming substrate according to any preceding Example, wherein at least one of the first particulate material and the second particulate material comprise one or more of cellulose and microcrystalline cellulose (MCC).

Example 18: An aerosol-forming substrate according to Example 17, wherein both the first particulate material and the second particulate material comprise one or more of cellulose and microcrystalline cellulose (MCC).

Example 19: An aerosol-forming substrate according to any preceding Example, wherein the particles of the first and second particulate materials are fibres.

Example 20: An aerosol-forming substrate according to any preceding Example, wherein the particles of the first particulate material and the second particulate material form a bimodal size distribution, wherein a first peak of the bimodal size distribution corresponds to the first particulate material and a second peak of the bimodal size distribution corresponds to the second particulate material.

Example 21: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate is a sheet.

Example 22: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate further comprises a binder.

Example 23: An aerosol-forming substrate according to Example 22, wherein the binder comprises carboxymethyl cellulose (CMC).

Example 24: An aerosol-forming substrate according to Example 22 or Example 23, wherein the aerosol-forming substrate has a binder content of about 5 weight percent.

Example 25: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate further comprises nicotine.

Example 26: An aerosol-forming substrate according to Example 25, wherein the aerosol-forming substrate has a nicotine content of about 1.5 weight percent.

Example 27: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate further comprises lactic acid.

Example 28: An aerosol-forming substrate according to Example 27, wherein the aerosol-forming substrate has a lactic acid content of about 2.5 weight percent.

Example 29: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate further comprises sucrose.

Example 30: An aerosol-forming substrate according to Example 29, wherein the aerosol-forming substrate has a sucrose content of about 2.5 weight percent.

Example 31: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate further comprises cellulose strengthening fibres.

Example 32: An aerosol-forming substrate according to Example 31, wherein the cellulose strengthening fibres have a D50 size of between 0.8 millimetres and 1.5 millimetres.

Example 33: An aerosol-forming substrate according to Example 31 or Example 32, wherein the aerosol-forming substrate has a cellulose fibre content of about 6 weight percent.

Example 34: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate further comprises one or more of nicotine, lactic acid, and sucrose.

Example 35: An aerosol-forming substrate according to any preceding Example, wherein the first particulate material has a density greater than 1.0 grams per centimetre cubed.

Example 36: An aerosol-forming substrate according to any preceding Example, wherein the second particulate material has a density of between 0.5 grams per centimetre cubed and 1.0 grams per centimetre cubed.

Example 37: An aerosol-forming substrate according to any preceding Example, wherein the ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate is at least 1:5.

Example 38: An aerosol-forming substrate according to any preceding Example, wherein the aerosol-forming substrate does not comprise tobacco.

Example 39: An aerosol-forming substrate according to any preceding Example, comprising between 5 weight percent and 30 weight percent of the first particulate material, and between 10 weight percent and 60 weight percent.

Example 40: An aerosol generating article comprising an aerosol-forming substrate according to any preceding Example.

Example 41: A process for manufacturing an aerosol-forming substrate, the process comprising: providing a first particulate material, the first particulate material being formed from particles having a D50 size of between 2 micrometres and 20 micrometres; providing a second particulate material, the second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres; mixing the first particulate material and the second particulate in an aqueous solution to form a slurry; casting the slurry; and drying the cast slurry to form a solid substrate.

Example 42: A process according to Example 41, comprising drying the cast slurry to form a sheet.

Example 43: A process according to Example 42, comprising crimping the sheet to form a plurality of strips.

Example 44: A process according to any of Examples 41 to 43, wherein the aqueous solution comprises a binder.

Example 45: A process for manufacturing an aerosol-forming substrate, the process comprising: providing a first particulate material formed from particles having a D50 size of between 2 micrometres and 20 micrometres; providing a second particulate material formed from particles having a D50 size of between 50 micrometres and 80 micrometres; and binding the first particulate material with the second particulate material to form a solid substrate.

Example 46: A process according to Example 45, comprising binding the first particulate material with the second particulate material to form a sheet.

Example 47: A process according to Example 46, comprising crimping the sheet to form a plurality of strips.

Example 48: A process according to any of Examples 45 to 47, wherein binding the first particulate material with the second particulate material comprises a casting process.

Example 49: A process according to any of Examples 45 to 47, wherein binding the first particulate material with the second particulate material comprises a pressing process.

Example 50: A process according to any of Examples 45 to 47, wherein binding the first particulate material with the second particulate material comprises an extrusion process.

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

Figure 1 illustrates an example of an aerosol generating article containing the aerosol-forming substrate as described herein;

Figure 2 is a plot of glycerol delivery per puff as a function of puff number for a three of aerosol generating articles each containing a different aerosol-forming substrate;

Figure 3 is a plot of nicotine delivery per puff as a function of puff number for a three of aerosol generating articles each containing a different aerosol-forming substrate; and

Figure 4 is an illustrative plot of the particle size distribution of an aerosol-forming substrate according to the present invention.

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

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

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

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

In the example of Figure 1, the aerosol-forming substrate 1020 is provided in the form of a plug made by crimping a sheet of aerosol-forming substrate. The sheet is gathered, crimped and wrapped in a filter paper (not shown) to form the plug.

The aerosol-forming substrate 1020 comprises a first particulate material and a second particulate material. The first particulate material is formed from particles having a D50 size of about 10 micrometres and a D95 size of about 33 micrometres. The second particulate material is formed from particles having a D50 size of about 59 micrometres and a D95 size of about 116 micrometres.

The first particulate material is formed from particles having a diameter of between 5 micrometres and 40 micrometres, and the second particulate material is formed from particles having a diameter of between 50 micrometres and 250 micrometres.

The ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate is about 1:2.

The first and second particulate materials are formed from microcrystalline cellulose (MCC).

The first particulate material has a density greater than 1.0 grams per centimetre cubed. The second particulate material has a density of between 0.5 grams per centimetre cubed and 1.0 grams per centimetre cubed.

The aerosol-forming substrate 1020 comprises about 15 weight percent of the first particulate material.

The aerosol-forming substrate 1020 comprises about 30 weight percent of the second particulate material.

The aerosol-forming substrate 1020 further comprises about 30 weight percent glycerine as an aerosol former.

The aerosol-forming substrate 1020 further comprises about 5 weight percent carboxymethyl cellulose as a binder.

The aerosol-forming substrate 1020 further comprises about 6 weight percent cellulose strengthening fibres.

The aerosol-forming substrate 1020 further comprises about 1.5 weight percent nicotine.

The aerosol-forming substrate 1020 further comprises about 2.5 weight percent lactic acid.

The aerosol-forming substrate 1020 further comprises about 2.5 weight percent sucrose.

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

Once engaged with an aerosol generating device, a user draws on the mouth-end 1012 of the smoking article 1000 and the aerosol-forming substrate 1020 is heated to a temperature of about 260 degrees Celsius. At this temperature, volatile compounds are evolved from the aerosol-forming substrate 1020. These compounds condense to form an aerosol. The aerosol is drawn through the filter 1050 and into the user's mouth.

Figure 2 shows the result of a study to determine the delivery of glycerol per puff as a function of the puff number for three aerosol generating articles each containing a different aerosol-forming substrate.

The first aerosol-forming substrate is a reference substrate which was a heat stick for use with an IQOS heating device manufactured by Philip Morris Products. The reference substrate comprises cast leaf tobacco. The line corresponding to the first aerosol-forming substrate is identified as 2003.

The second aerosol-forming substrate comprises about 13.3 weight percent of the first particulate material and about 26.7 weight percent of the second particulate material. Accordingly, in the second aerosol-forming substrate, the ratio of the mass of the first (smaller) particulate material to the mass of the second (larger) particulate material in the aerosol-forming substrate is about 1:2. The line corresponding to the second aerosol-forming substrate is identified as 2004. The second aerosol-forming substrate is in accordance with the present invention.

The third aerosol-forming substrate comprises about 40 weight percent of the second (larger) particulate material. The third aerosol-forming substrate does not comprise any amount of the first (smaller) particulate material. The line corresponding to the third aerosol-forming substrate is identified as 2005.

The glycerol yield in micrograms per puff is plotted on the vertical axis, identified as 2001. The puff number is plotted on the horizontal axis, identified as 2002.

As can be seen from the graph shown in Figure 2, it was found that the delivery of glycerol was advantageously sustained over the full 12 puffs in the second aerosol-forming substrate 2004 according to the present invention. Indeed, it was advantageously demonstrated that the second aerosol-forming substrate 2004 according to the present invention exhibited greater glycerol yield even than the first reference aerosol-forming substrate 2003.

By contrast, the third aerosol-forming substrate 2005 which does not contain a mixture of the first and second particulate material exhibits significantly lower delivery of glycerol over the 12 puffs.

The test also demonstrated that providing a ratio of the mass of the first (smaller) particulate material to the mass of the second (larger) particulate material in the aerosol-forming substrate of about 1:2 results is favourable glycerol delivery.

Figure 3 shows the result of a study to determine the delivery of nicotine per puff as a function of the puff number for the same three aerosol generating articles each containing the same aerosol-forming substrates described above in reference to Figure 2.

The first aerosol-forming substrate, which is a reference substrate, is identified as 3003.

The second aerosol-forming substrate, which is according to the present invention, is identified as 3004.

The third aerosol-forming substrate, which does not contain a mixture of the first and second particulate material, is identified as 3005.

The nicotine yield in micrograms per puff is plotted on the vertical axis, identified as 3001. The puff number is plotted on the horizontal axis, identified as 3002.

As can be seen from the graph shown in Figure 3, it was found that the delivery of nicotine was advantageously sustained over the full 12 puffs in the second aerosol-forming substrate 3004

according to the present invention when compared to the third aerosol-forming substrate 3005, which does not contain a mixture of the first and second particulate material.

Figure 4 is an illustrative plot of the particle size distribution of an aerosol-forming substrate according to the present invention. The graph shown in Figure 4 is for illustrative purposes only and is not based on actual data. Particle size is plotted on the horizontal axis, identified as 4001. The frequency of a given particle size is plotted on the vertical axis, identified as 4002.

As can be seen from Figure 4, the particle size distribution of an aerosol-forming substrate according to the present invention exhibits a bimodal distribution pattern. The lower peak corresponds to the first (smaller) particulate material. From the lower peak, the $D50_1$ figure for the first particulate material may be determined and is identified on the graph. The $D95_1$ figure for the first particulate material is also identified on the graph. From the higher peak, the $D50_2$ figure for the second particulate material may be determined and is identified on the graph. The $D95_2$ figure for the second particulate material is also identified on the graph.

The ratio of the mass of the first (smaller) particulate material to the mass of the second (larger) particulate material in the aerosol-forming substrate is about 1:2. This is demonstrated in the distribution on Figure 4 since the peak corresponding to the second particulate material is approximately twice as high as the first peak corresponding to the first particulate material.

CLAIMS:

1. An aerosol-forming substrate for use in an aerosol generating system, wherein the aerosol-forming substrate is a solid unitary body and comprises;

a first particulate material, and

a second particulate material,

the first particulate material being formed from particles having a D50 size of between 2 micrometres and 20 micrometres, and the second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres.

2. An aerosol-forming substrate according to claim 1, wherein the ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate is no more than 1:2.

3. An aerosol-forming substrate according to any preceding claim, wherein the first particulate material is formed from particles having a D50 size of 10 micrometres, and the second particulate material is formed from particles having a D50 size of 59 micrometres.

4. An aerosol-forming substrate according to any preceding claim, wherein the first particulate material is formed from particles having a D95 size of between 10 micrometres and 60 micrometres, and the second particulate material is formed from particles having a D95 size of between 80 micrometres and 130 micrometres.

5. An aerosol-forming substrate according to claim 4, wherein the first particulate material is formed from particles having a D95 size of 33 micrometres, and the second particulate material is formed from particles having a D95 size of 116 micrometres.

6. An aerosol-forming substrate according to any preceding claim, wherein the first particulate material is formed from particles having a diameter of between 5 micrometres and 40 micrometres, and the second particulate material being formed from particles having a diameter of between 50 micrometres and 250 micrometres.

7. An aerosol-forming substrate according to any preceding claim, wherein the first particulate material and the second particulate material are formed from the same material.

8. An aerosol-forming substrate according to any preceding claim, wherein at least one of the first particulate material and the second particulate material comprise one or more of cellulose and microcrystalline cellulose (MCC).

9. An aerosol-forming substrate according to any preceding claim, further comprising a binder.

10. An aerosol-forming substrate according to any preceding claim, further comprising one or more of nicotine, lactic acid, and sucrose.

11. An aerosol-forming substrate according to any preceding claim, further comprising cellulose strengthening fibres, wherein the cellulose strengthening fibres have a D50 size of between 0.8 millimetres and 1.5 millimetres.

12. An aerosol-forming substrate according to any preceding claim, wherein the ratio of the mass of the first particulate material to the mass of the second particulate material in the aerosol-forming substrate is at least 1:5.

13. An aerosol-forming substrate according to any preceding claim, wherein the aerosol-forming substrate does not comprise tobacco.

14. An aerosol generating article comprising an aerosol-forming substrate according to any preceding claim.

15. A process for manufacturing an aerosol-forming substrate, the process comprising:

providing a first particulate material, the first particulate material being formed from particles having a D50 size of between 2 micrometres and 20 micrometres;

providing a second particulate material, the second particulate material being formed from particles having a D50 size of between 50 micrometres and 80 micrometres;

mixing the first particulate material and the second particulate in an aqueous solution to form a slurry;

casting the slurry; and

drying the cast slurry to form a solid substrate.

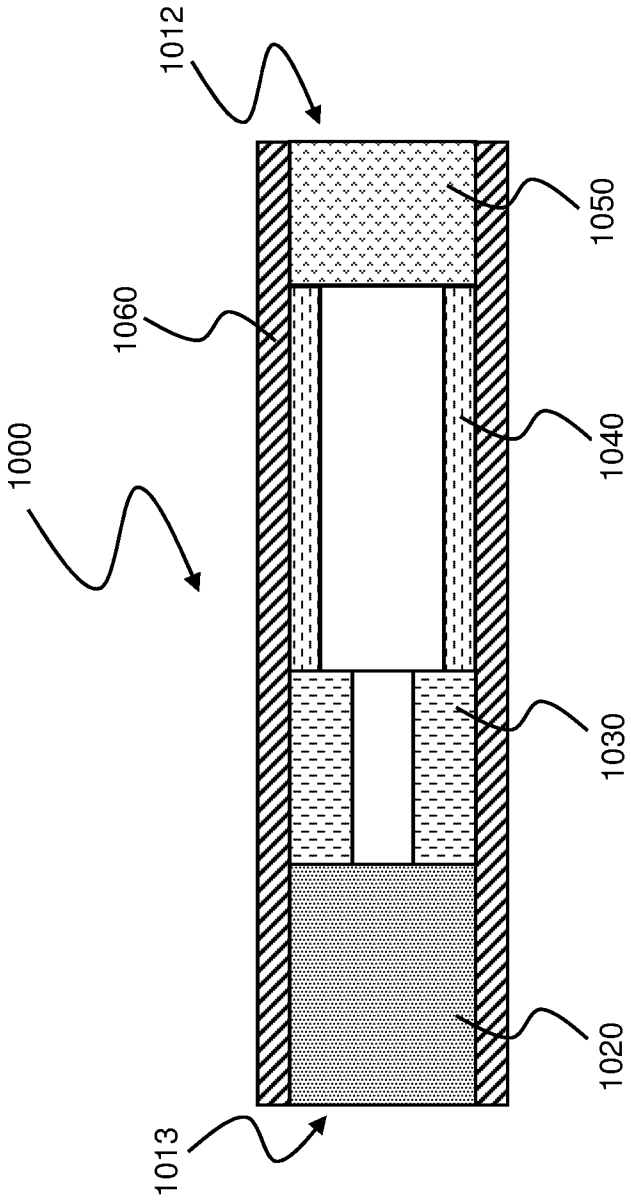

Figure 1

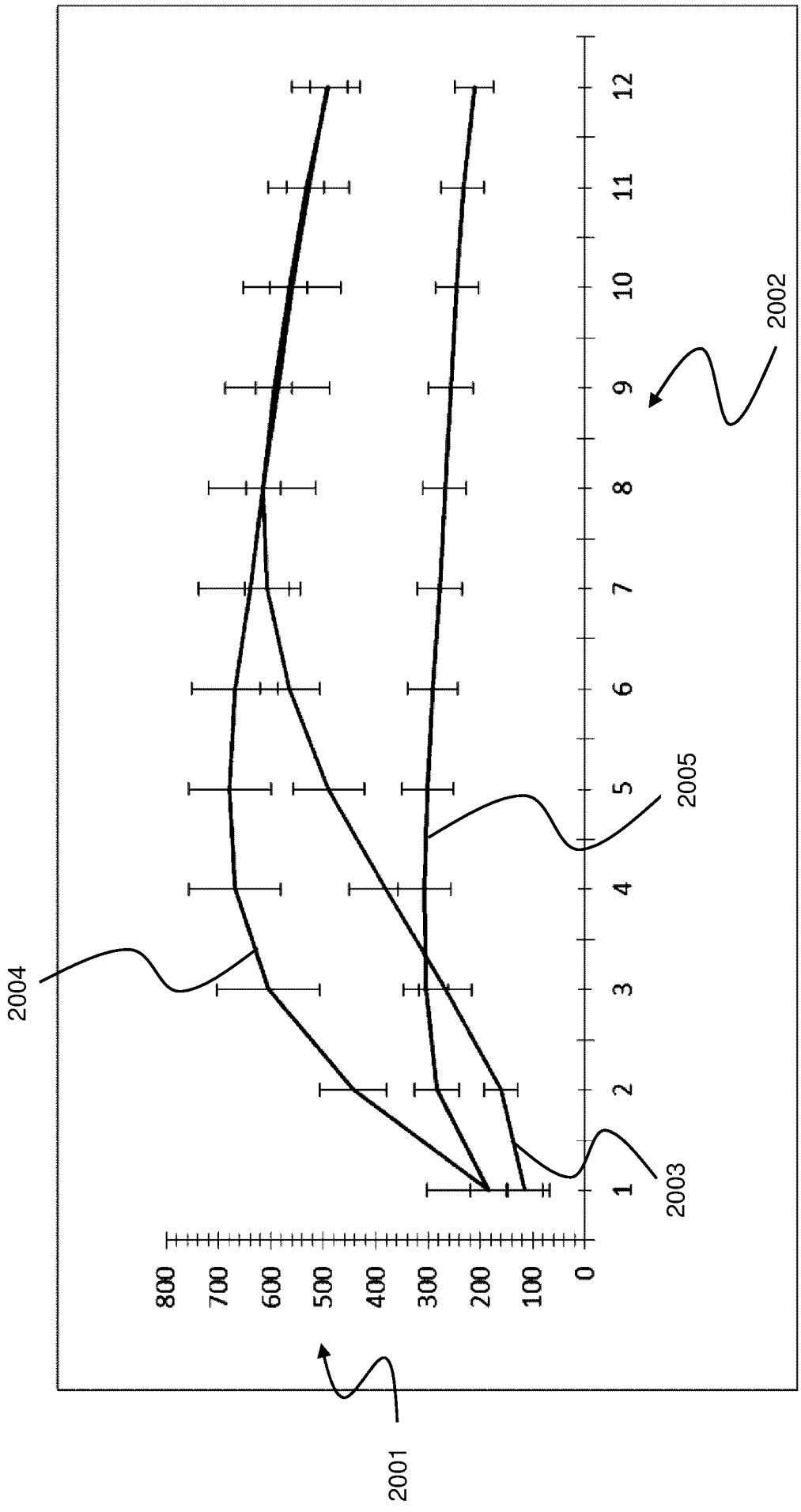
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Figure 2

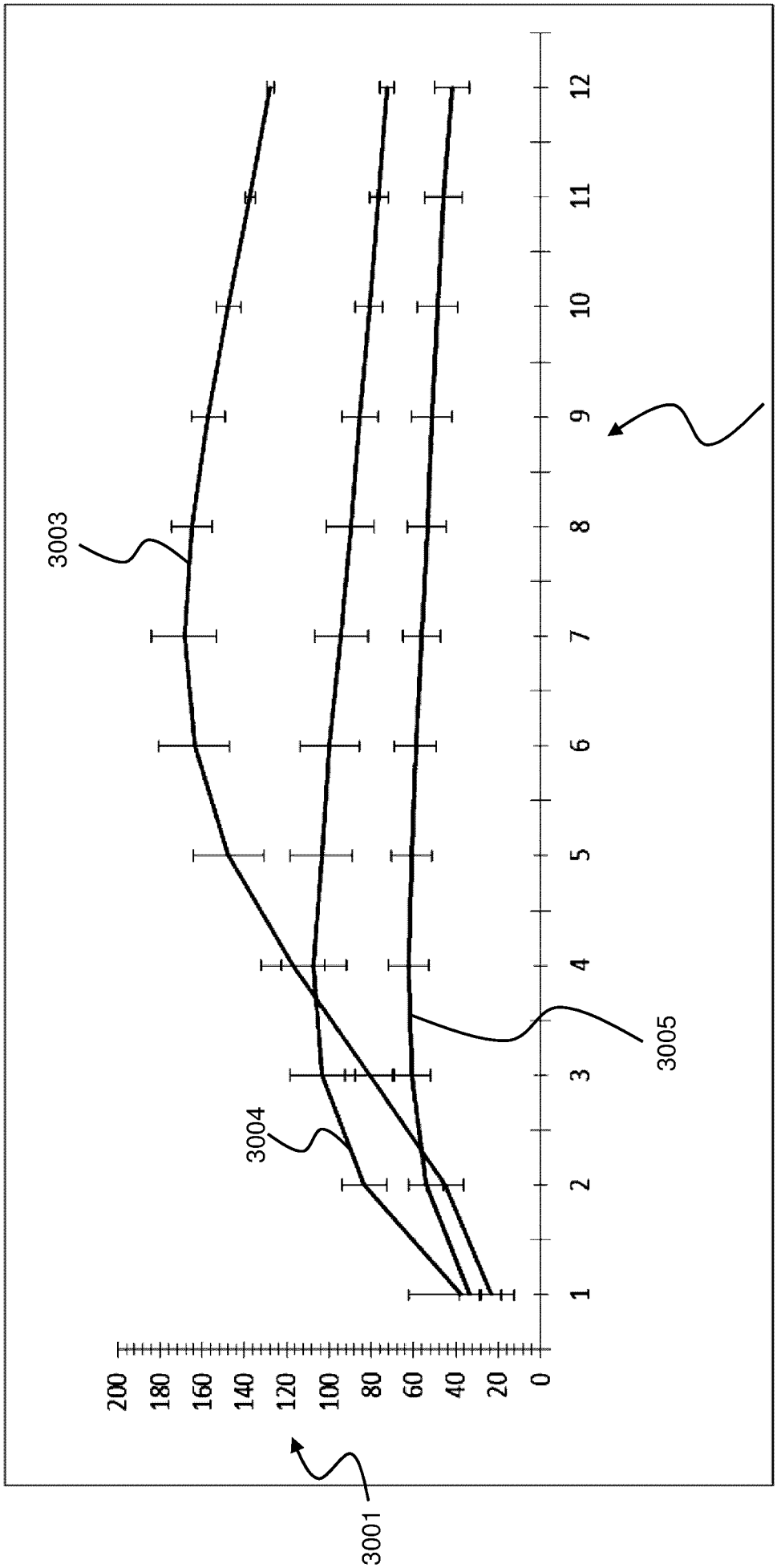
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Figure 3

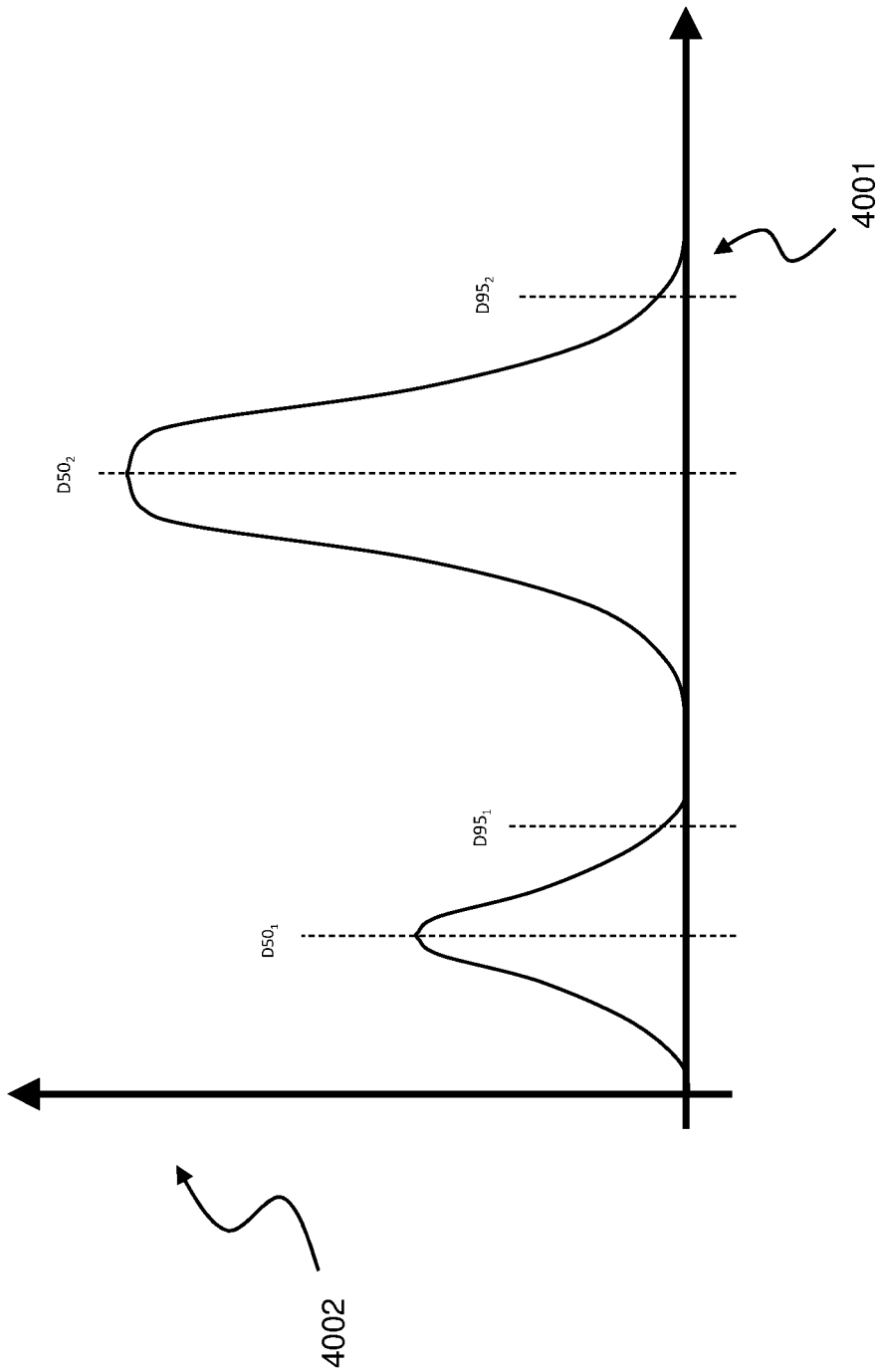

Figure 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/073221

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24B15/28 A24B15/30 A24F40/20 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

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2018/122095 A1 (PHILIP MORRIS PRODUCTS SA [CH]) 5 July 2018 (2018-07-05) the whole document	1-15
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-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 October 2022	08/11/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Piret-Viprey, E

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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