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AN AEROSOL-GENERATING SUBSTRATE
CIRCUMSCRIBED BY A HIGH-POROSITY
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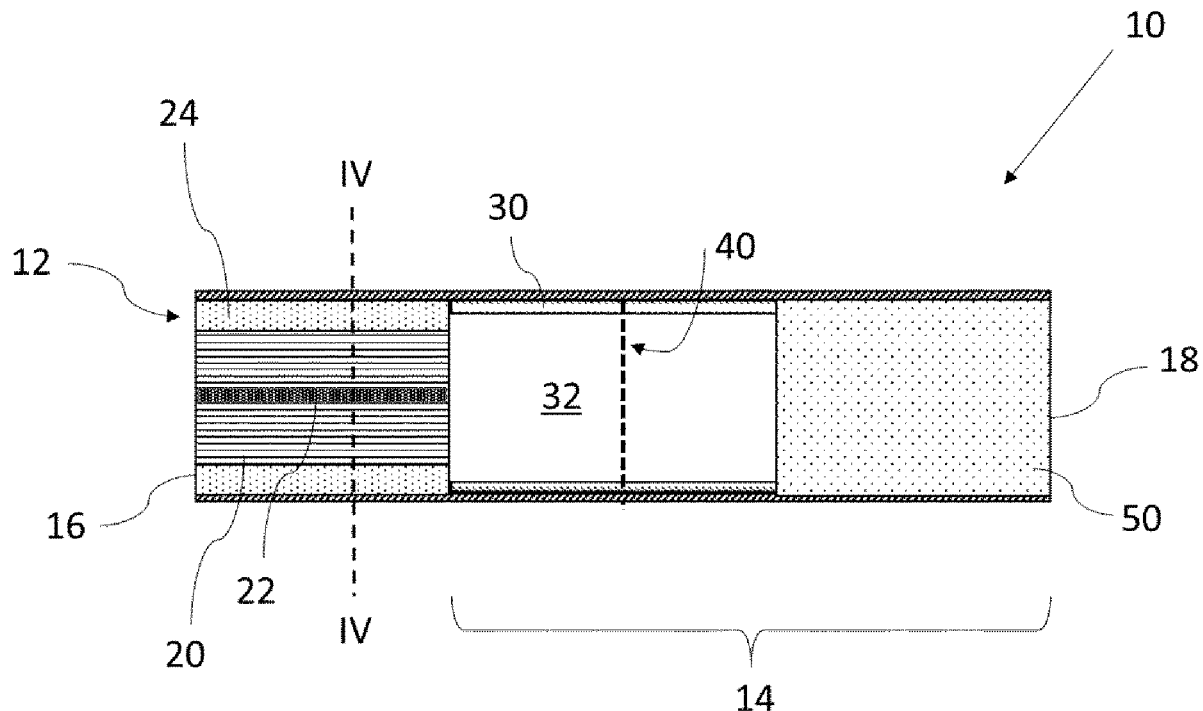
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(57)

ABSTRACT

An aerosol-generating article is provided, including: an aerosol-generating rod extending from an upstream end to a downstream end; and a downstream section provided downstream of the aerosol-generating rod and abutting the downstream end of the aerosol-generating rod, the aerosol-generating rod including a substantially cylindrical core portion having a longitudinal axis and an annular portion surrounding and extending coaxially with the core portion, the annular portion being air permeable, such that an upstream end of the annular portion internal is in fluid communication with the downstream section, the core portion including an aerosol-generating substrate and having a cross-sectional porosity of from 0.10 to 0.45, a cross-sectional porosity of the annular portion being at least 120 percent of the cross-sectional porosity of the core portion, and a thickness of the annular portion being at least 0.5 millimetre. An aerosol-generating system including the aerosol-generating article and an aerosol-generating device is also provided.



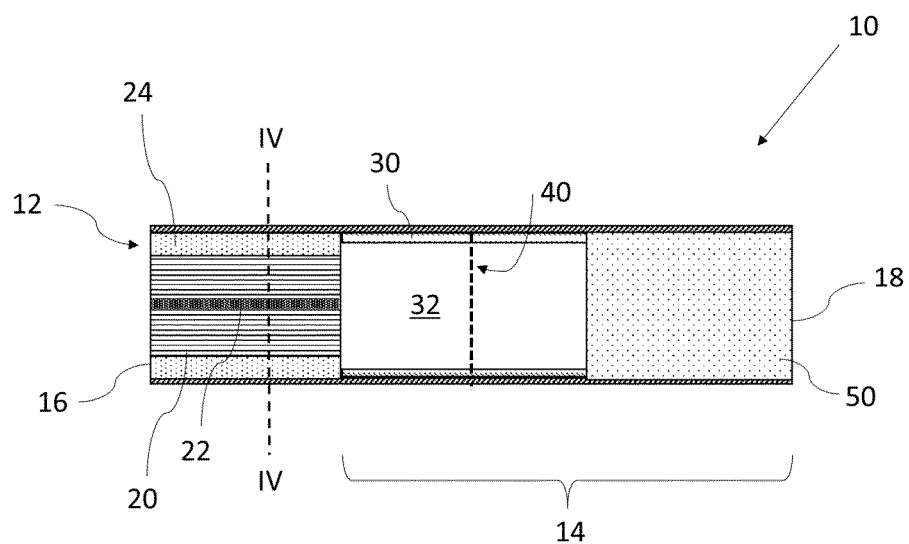


Figure 1

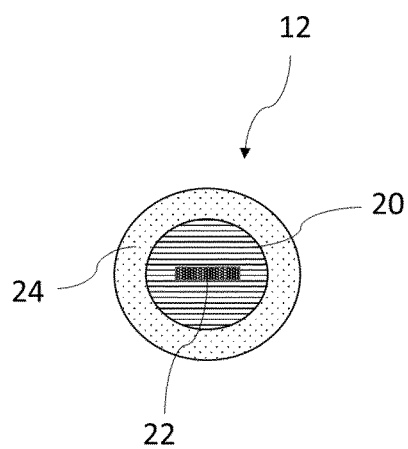


Figure 2

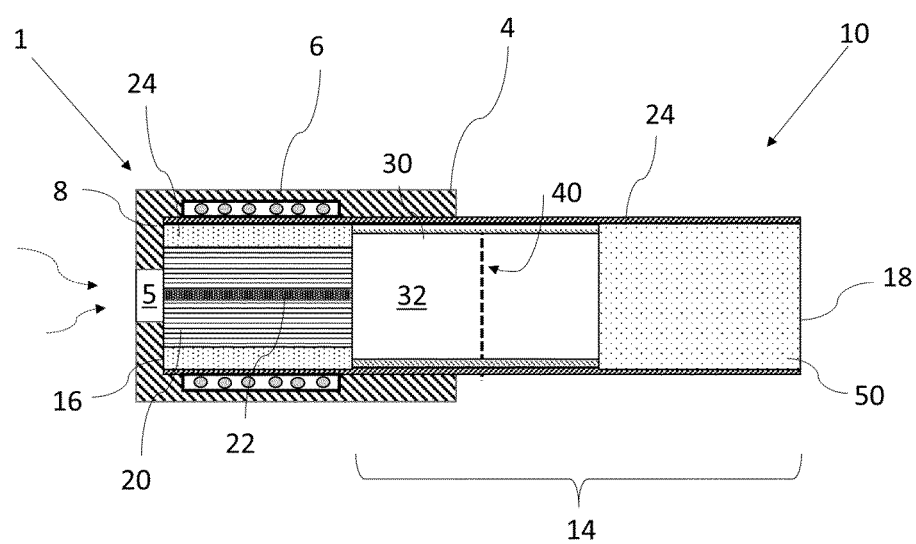


Figure 3

**AEROSOL-GENERATING ARTICLE WITH
AN AEROSOL-GENERATING SUBSTRATE
CIRCUMSCRIBED BY A HIGH-POROSITY
ANNULAR PORTION**

[0001] The present invention relates to an aerosol-generating article comprising an aerosol-generating substrate and adapted to produce an inhalable aerosol upon heating.

[0002] Aerosol-generating articles in which an aerosol-generating substrate, such as a tobacco-containing substrate, is heated rather than combusted, are known in the art. Typically, in such heated smoking articles an aerosol is generated by the transfer of heat from a heat source to a physically separate aerosol-generating substrate or material, which may be located in contact with, within, around, or downstream of the heat source. During use of the aerosol-generating article, volatile compounds are released from the aerosol-generating substrate by heat transfer from the heat source and are entrained in air drawn through the aerosol-generating article. As the released compounds cool, they condense to form an aerosol.

[0003] A number of prior art documents disclose aerosol-generating devices for consuming aerosol-generating articles. Such devices include, for example, electrically heated aerosol-generating devices in which an aerosol is generated by the transfer of heat from one or more electrical heater elements of the aerosol-generating device to the aerosol-generating substrate of a heated aerosol-generating article. For example, electrically heated aerosol-generating devices have been proposed that comprise an internal heater blade which is adapted to be inserted into the aerosol-generating substrate. As an alternative, inductively heatable aerosol-generating articles comprising an aerosol-generating substrate and a susceptor arranged within the aerosol-generating substrate have been proposed by WO 2015/176898. A further alternative has been described in WO 2020/115151, which discloses an aerosol-generating article used in combination with an external heating system comprising one or more heating elements arranged around the periphery of the aerosol-generating article. For example, external heating elements may be provided in the form of flexible heating foils on a dielectric substrate, such as polyimide.

[0004] Aerosol-generating articles in which a tobacco-containing substrate is heated rather than combusted present a number of challenges that were not encountered with conventional smoking articles. First of all, tobacco-containing substrates are typically heated to significantly lower temperatures compared with the temperatures reached by the combustion front in a conventional cigarette. This may have an impact on nicotine release from the tobacco-containing substrate and nicotine delivery to the consumer. Additionally, it may be difficult to heat homogeneously the entirety of the tobacco-containing substrate provided within the article.

[0005] In aerosol-generating systems wherein heat is supplied internally, such as by way of a heater element that is inserted into the rod of aerosol-generating substrate, it may be difficult for the heat supplied by the heater element to be transferred efficiently all the way to the periphery of the rod. On the other hand, in aerosol-generating systems wherein heat is supplied externally, such as by inserting the aerosol-generating article into a cavity of a heating device that comprises one or more heater elements arranged about a side

wall of the cavity, it may be difficult for the heat supplied by the heater element to be transferred efficiently all the way to the core of the rod.

[0006] Difficulties in transferring heat efficiently may lead to portions of the rod of aerosol-generating substrate being unable to reach a temperature sufficient to promote release of aerosol species. As a result, those portions of the rod of aerosol-generating substrate may not substantially contribute to the overall aerosol delivery of the aerosol-generating article, and so an efficiency of use of the aerosol-generating substrate provided in the rod may undesirably be less than ideal.

[0007] Difficulties in transferring heat efficiently may also lead to portions of the rod of aerosol-generating substrate wherein a temperature sufficient to promote release of aerosol species is indeed reached, but only over a small fraction of the use cycle of the aerosol-generating article. In those portions of the rod of aerosol-generating substrate a temperature profile during use may differ from an intended temperature profile, and so the aerosol-generating substrate may undesirably be underutilized.

[0008] The issues discussed above may be further complicated by the fact that an aerosol-generating article may potentially be heated in any aerosol-generating device available on the market provided that it is compatible with the size—namely, the diameter—of the aerosol-generating article, irrespective of whether the aerosol-generating article and that specific model of aerosol-generating device have been devised to be used together or not. One such potential mismatch of aerosol-generating article and device may lead to the aerosol-generating substrate being exposed to a non-optimised temperature profile, possibly in combination with a non-ideal airflow mechanism through the system during use. This may unfavorably impact aerosol delivery and temperatures, and generally alter the system's conditions of use relative to the intended ones.

[0009] A need is thus generally felt for an aerosol-generating article that may be adapted to address one or more of the issues discussed above. Additionally, it would be desirable to provide an aerosol-generating article that may be easy to manufacture and that may make the whole production chain more sustainable and cost-effective. Therefore, it would be desirable to provide a new and improved aerosol-generating article adapted to satisfy at least one of the needs described above. Further, it would be desirable to provide one such aerosol-generating article that can be manufactured efficiently and at high speed.

[0010] The present disclosure relates to an aerosol-generating article for producing an inhalable aerosol upon heating. The aerosol-generating article may comprise an aerosol-generating rod extending from an upstream end to a downstream end. The aerosol-generating article may further comprise a downstream section provided downstream of the aerosol-generating rod. The downstream section may abut the downstream end of the aerosol-generating rod. The aerosol-generating rod may comprise a substantially cylindrical core portion having a longitudinal axis and an annular portion surrounding and extending coaxially with the core portion. The annular portion may be air permeable. The annular portion may be in direct fluid communication with the downstream section. The core portion may comprise an aerosol-generating substrate. The core portion may have a cross-sectional porosity of from 0.10 to 0.45. A cross-

sectional porosity of the annular portion may be at least 120 percent of the cross-sectional porosity of the core portion.

[0011] The present disclosure further relates to an aerosol-generating system comprising an aerosol-generating article as described above and an aerosol-generating device comprising a heating chamber open at a proximal end to at least partly receive the aerosol-generating rod to heat the aerosol-generating substrate. The aerosol-generating device may comprise an opening at a distal end to admit airflow into the heating chamber along a longitudinal axis of the heating chamber. A diameter of the opening may be smaller than the internal diameter of the annular portion.

[0012] According to the present invention there is provided an aerosol-generating rod extending from an upstream end to a downstream end; and a downstream section provided downstream of the aerosol-generating rod and abutting the downstream end of the aerosol-generating rod. The aerosol-generating rod comprises a substantially cylindrical core portion having a longitudinal axis and an annular portion surrounding and extending coaxially with the core portion. The annular portion is air permeable, such that an upstream end of the annular portion is in fluid communication with the downstream section. The core portion comprises an aerosol-generating substrate and has a cross-sectional porosity of from 0.10 to 0.45; a cross-sectional porosity of the annular portion being at least 120 percent of the cross-sectional porosity of the core portion.

[0013] According to the present invention there is provided an aerosol-generating system comprising an aerosol-generating article as described above and an aerosol-generating device. The aerosol-generating device comprises a heating chamber open at a proximal end to at least partly receive the aerosol-generating rod to heat the aerosol-generating substrate. The aerosol-generating device comprises an opening at a distal end to admit airflow into the heating chamber along a longitudinal axis of the heating chamber. A diameter of the opening is smaller than the internal diameter of the annular portion.

[0014] The aerosol-generating article according to the present invention therefore provides a novel configuration of the section of the aerosol-generating article configured to generate an aerosol when heated. In more detail, a substantially cylindrical core portion is provided that contains an aerosol-generating substrate and is circumscribed by an air permeable annular portion having a comparatively higher cross-sectional porosity. The annular portion is sized such that direct fluid communication may be established between the annular portion and the downstream section.

[0015] Because the annular portion is air permeable and has a significantly higher cross-sectional porosity compared with the core portion, a resistance to draw (RTD) of the annular portion is substantially lower than an RTD of the core portion. Thus, if the aerosol-generating article is not paired with an aerosol-generating device, air drawn into the aerosol-generating article by a consumer may flow primarily, if not entirely, through the annular portion and around the core portion. Thus, the aerosol-generating substrate in the core portion may be substantially bypassed by such flow of air. As such, if a consumer inhales through the aerosol-generating article when the aerosol-generating article is not paired with an aerosol-generating device, functionality of the aerosol-generating article may be substantially disabled.

[0016] This is advantageous in that it generally prevents misuse of the aerosol-generating article. For example,

attempts on the part of a consumer to use the aerosol-generating article as a conventional, combustible smoking article would generally be unsuccessful, as airflow into the core portion at an upstream end of the aerosol-generating article would be insufficient for sustaining combustion.

[0017] Further, as the aerosol-generating substrate is concentrated at the core of the aerosol-generating rod, in systems wherein heat is supplied to the aerosol-generating article internally—as will be discussed in more detail below—a homogeneous supply of heat to all of the aerosol-generating substrate during use may advantageously be facilitated. Because the annular portion circumscribing the core portion is not meant to contribute to aerosol generation, supply of heat to the annular portion is not at all crucial. The fact that air permeable annular portion is likely to be heated less in systems wherein heat is supplied to the aerosol-generating article internally may even be beneficial, as in certain embodiments the annular portion may, to an extent, work as a thermally insulating sleeve.

[0018] Additionally, the core portion and the annular portion may be dimensioned such that the aerosol-generating article is only compatible for use with an aerosol-generating device having a specific design, such that, when the aerosol-generating article is coupled with the aerosol-generating device, an upstream end of the annular portion becomes occluded while, at the same time, airflow into the core portion is enabled. By contrast, if the aerosol-generating article is coupled with the wrong aerosol-generating device, an upstream end of the core portion becomes at least partly occluded while, at the same time, airflow into the annular portion is enabled, which makes use of the aerosol-generating article virtually impossible.

[0019] For example, in systems in accordance with the present invention, an opening may be provided at a distal end of the aerosol-generating device to enable flow of air into a heating chamber into which the aerosol-generating article is received. By ensuring that a diameter of the opening is smaller than the internal diameter of the annular portion, it is advantageously possible to ensure full compatibility of use between the aerosol-generating article and the aerosol-generating device.

[0020] This has the benefit that only use of the aerosol-generating article with the corresponding, dedicated aerosol-generating device will be fully functional and ensure that the aerosol-generating substrate is subjected to a predetermined heating profile designed specifically for that aerosol-generating substrate. On the other hand, the improper matching of the aerosol-generating article with any aerosol-generating device other than the one for which the aerosol-generating article is intended will generally be ineffective. Mismatches of aerosol-generating article and aerosol-generating device will therefore be discouraged, whilst at the same time ensuring that, when the aerosol-generating article is correctly paired with the intended aerosol-generating device, aerosol delivery and other parameters may be optimised.

[0021] As described briefly above, in accordance with the present invention there is provided an aerosol-generating article for generating an inhalable aerosol upon heating. The aerosol-generating article comprises an aerosol-generating rod that extends from an upstream end to a downstream end. A core portion of the aerosol-generating rod comprises an aerosol-generating substrate.

[0022] The term “aerosol generating article” is used herein to denote an article wherein an aerosol generating substrate

is heated to produce and deliver inhalable aerosol to a consumer. As used herein, the term “aerosol generating substrate” denotes a substrate capable of releasing volatile compounds upon heating to generate an aerosol.

[0023] 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 a flavour generating substrate, such as tobacco. Known heated aerosol generating articles include, for example, electrically heated aerosol generating articles and aerosol generating articles in which an aerosol is generated by the transfer of heat from a combustible fuel element or heat source to a physically separate aerosol forming material. For example, aerosol generating articles according to the invention find particular application in aerosol generating systems comprising an electrically heated aerosol generating device having an internal heater blade which is adapted to be inserted into the rod of aerosol generating substrate. Aerosol generating articles of this type are described in the prior art, for example, in EP 0822670.

[0024] As used herein, the term “aerosol generating device” refers to a device comprising a heater element that interacts with the aerosol generating substrate of the aerosol generating article to generate an aerosol.

[0025] As used herein with reference to the present invention, the term “rod” is used to denote a generally cylindrical element of substantially circular, oval or elliptical cross-section.

[0026] As used herein, the term “longitudinal” refers to the direction corresponding to the main longitudinal axis of the aerosol-generating article, which extends between the upstream and downstream ends of the aerosol-generating article. As used herein, the terms “upstream” and “downstream” describe the relative positions of elements, or portions of elements, of the aerosol-generating article in relation to the direction in which the aerosol is transported through the aerosol-generating article during use.

[0027] During use, air is drawn through the aerosol-generating article in the longitudinal direction. The term “transverse” refers to the direction that is perpendicular to the longitudinal axis. Any reference to the “cross-section” of the aerosol-generating article or a component of the aerosol-generating article refers to the transverse cross-section unless stated otherwise.

[0028] The term “length” denotes the dimension of a component of the aerosol-generating article in the longitudinal direction. For example, it may be used to denote the dimension of the rod or of the elongate tubular elements in the longitudinal direction.

[0029] The aerosol-generating article further comprises a downstream section at a location downstream of the aerosol-generating rod. As will become apparent from the following description of different embodiments of the aerosol-generating article of the invention, the downstream section may comprise one or more downstream elements.

[0030] In some embodiments, the downstream section may comprise a hollow section between the mouth end of the aerosol-generating article and the aerosol-generating rod. The hollow section may comprise a hollow tubular element.

[0031] As used herein, the term “hollow tubular segment” or “hollow tubular element” is used to denote a generally elongate element defining a lumen or airflow passage along a longitudinal axis thereof. In particular, the term “tubular” will be used in the following with reference to an element or segment having a substantially cylindrical cross-section and defining at least one airflow conduit establishing an uninterrupted fluid communication between an upstream end of the tubular element or segment and a downstream end of the tubular element or segment. However, it will be understood that alternative geometries (for example, alternative cross-sectional shapes) of the tubular element or segment may be possible.

[0032] In the context of the present invention a hollow tubular segment or hollow tubular element provides an unrestricted flow channel. This means that the hollow tubular segment or hollow tubular element provides a negligible level of resistance to draw (RTD). The term “negligible level of RTD” is used to describe an RTD of less than 1 mm H₂O per 10 millimetres of length of the hollow tubular segment or hollow tubular element, preferably less than 0.4 mm H₂O per 10 millimetres of length of the hollow tubular segment or hollow tubular element, more preferably less than 0.1 mm H₂O per 10 millimetres of length of the hollow tubular segment or hollow tubular element.

[0033] The flow channel should therefore be free from any components that would obstruct the flow of air in a longitudinal direction. Preferably, the flow channel is substantially empty.

[0034] In the present specification, a “hollow tubular segment” or “hollow tubular element” may also be referred to as a “hollow tube” or a “hollow tube segment”.

[0035] In some embodiments, the aerosol-generating article may comprise a ventilation zone at a location along the downstream section. In more detail, the aerosol-generating article may in certain embodiments comprise a ventilation zone at a location along the hollow tubular element. As such, fluid communication is established between the flow channel internally defined by the hollow tubular element and the outer environment.

[0036] In aerosol-generating articles in accordance with the present invention, a length of the aerosol-generating rod may be at least 5 millimetres. Preferably, a length of the aerosol-generating rod is at least 10 millimetres. More preferably, a length of the aerosol-generating rod is at least 12 millimetres. Even more preferably, a length of the aerosol-generating rod is at least 15 millimetres.

[0037] Preferably, a length of the aerosol-generating rod is less than or equal to 45 millimetres. More preferably, a length of the aerosol-generating rod is less than or equal to 40 millimetres. Even more preferably, a length of the aerosol-generating rod is less than or equal to 40 millimetres.

[0038] In preferred embodiments, a length of the aerosol-generating rod is less than or equal to 35 millimetres. More preferably, a length of the aerosol-generating rod is less than or equal to 30 millimetres. Even more preferably, a length of the aerosol-generating rod is less than or equal to 25 millimetres. In particularly preferred embodiments, a length of the aerosol-generating rod is less than or equal to 22 millimetres.

[0039] In some embodiments, a length of the aerosol-generating rod is from 10 millimetres to 45 millimetres, preferably from 10 millimetres to 40 millimetres, more preferably from 10 millimetres to 35 millimetres, even more

preferably from 10 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the aerosol-generating rod is from 10 millimetres to 25 millimetres, preferably from 10 millimetres to 22 millimetres.

[0040] In other embodiments, a length of the aerosol-generating rod is from 12 millimetres to 45 millimetres, preferably from 12 millimetres to 40 millimetres, more preferably from 12 millimetres to 35 millimetres, even more preferably from 12 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the aerosol-generating rod is from 12 millimetres to 25 millimetres, preferably from 12 millimetres to 22 millimetres.

[0041] In further embodiments, a length of the aerosol-generating rod is from 15 millimetres to 45 millimetres, preferably from 15 millimetres to 40 millimetres, more preferably from 15 millimetres to 35 millimetres, even more preferably from 15 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the aerosol-generating rod is from 15 millimetres to 25 millimetres, preferably from 15 millimetres to 22 millimetres.

[0042] As described briefly above, in aerosol-generating articles in accordance with the present invention, the aerosol-generating rod comprises a core portion having a longitudinal axis. Preferably, the core portion has a substantially uniform cross-section along the length of the aerosol-generating rod. Particularly preferably, the core portion has a substantially circular cross-section, and so the core portion can be described as substantially cylindrical.

[0043] The core portion comprises an aerosol-generating substrate and has a cross-sectional porosity from 0.10 to 0.45.

[0044] As used herein, the term “porosity” refers to a fraction of void space in an air permeable or porous body. In more detail, the term “porosity” is used herein with reference to the “cross-sectional porosity” of one such body, that is, the fraction of void space in a cross-sectional area of the air permeable or porous body, for example a cross-section of the cylindrical core portion of the aerosol-generating rod in an aerosol-generating article in accordance with the present invention. The cross-sectional porosity is the area fraction of void space in a transverse cross-sectional area of the cylindrical core portion. The transverse cross-sectional area of the cylindrical core portion is the area of the cylindrical core portion in a plane that is perpendicular to the longitudinal axis of the aerosol-generating rod.

[0045] As used herein, the terms “porosity distribution values”, or “cross-sectional porosity distribution values”, refer to the standard deviation of porosity values locally determined within each of a plurality of identically dimensioned sub-areas of the transverse cross-sectional area of an air permeable or porous body. The porosity within a sub-area may be referred to as “local porosity”, and the cross-sectional porosity distribution value is the standard deviation of the local porosity values over the transverse cross-sectional area of the air permeable or porous body.

[0046] A sub-area refers to an area that is smaller than the transverse cross-sectional area of the body. The plurality of identically dimensioned sub-areas covers the entire transverse cross-sectional area of the body. Preferably, each sub-area overlaps at least one adjacent sub-area, preferably more than one adjacent sub-area. Preferably, each sub-area overlaps at least one adjacent sub-area by between 10 percent and 95 percent. Preferably, each sub-area is less than 20 percent of the entire transverse cross-sectional area, for

example less than 15 percent of the entire transverse cross-sectional area, preferably less than 10 percent of the entire transverse cross-sectional area.

[0047] In the case of a cylindrical body, such as the core portion of the aerosol-generating rod in an aerosol-generating article in accordance with the present invention, the transverse cross-sectional area will be substantially circular. Each sub-area is preferably rectangular or square. It is preferred that a sub-area overlaps at least 50 percent of the transverse cross-sectional area before it is included in the calculation of porosity distribution, particularly preferably at least 70 percent or at least 80 percent or at least 90 percent of the transverse cross-sectional area before it is included in the calculation of porosity distribution.

[0048] In certain preferred embodiments wherein, as will be described in more detail below, the aerosol-generating substrate comprises a sheet of aerosol-forming material gathered to form the core portion, then the cross-sectional porosity of the core portion is a function of the diameter of the core portion and of the width and thickness of the sheet of aerosol-forming material. In such embodiments, the cross-sectional porosity of the core portion may be calculated using the formula:

$$P_{cross} = \frac{\pi(D_{cp}/2)^2 - (W_{sheet} \cdot T_{sheet})}{\pi(D_{cp}/2)^2}$$

[0049] where:

[0050] P_{cross} =cross-sectional porosity

[0051] D_{cp} =Diameter of the core portion

[0052] W_{sheet} =Width of the sheet gathered to form the core portion

[0053] T_{sheet} =Thickness of the sheet gathered to form the core portion

[0054] The cross-sectional porosity distribution value refers to a measure of the variation in local porosity over different sub-areas of the transverse cross-sectional area of the body.

[0055] The cross-sectional porosity distribution value is, thus, a quantitative measure of the distribution of porosity over the transverse area of the article. The local porosity of each sub-area may be calculated using the formula:

$$P_{local} = \frac{A_{local} - A_{sheet}}{A_{local}}$$

[0056] Where,

[0057] P_{local} =cross-sectional porosity of a sub-area

[0058] A_{local} =Area of the sub-area

[0059] A_{sheet} =Area of tobacco material within the sub-area

[0060] The cross-sectional porosity distribution value may be seen to be a measure of the uniformity of porosity of a body, such as a cylindrical body. For example, if the standard deviation of the local porosity is low, then the voids within the cylindrical body are likely to be uniformly distributed over the entire transverse area of the cylindrical body, and of similar sizes. However, if the standard deviation is high then the voids are not uniformly distributed over the transverse area of the cylindrical body, some sections of the cylindrical body having a high porosity and some having low porosity.

For a given cross-sectional porosity, a high cross-sectional porosity distribution value may be an indication that a cylindrical body has a small number of relatively large through-channels, whereas a low cross-sectional porosity distribution value may indicate that a cylindrical body has a high number of relatively small through-channels.

[0061] A cross-sectional porosity distribution value may be determined from local porosity values calculated for multiple sub-areas covering the transverse cross-section of a single body. A cross-sectional porosity distribution value relating to any individual rod may be compared with that of another individual body. Alternatively, a cross-sectional porosity distribution value may be calculated from local porosity values derived from a number of different bodies of approximately the same cross sectional area and approximately the same cross-sectional porosity, for example a set or batch of cylindrical bodies. The cross-sectional porosity distribution value from a batch of bodies may be used to evaluate the quality of porosity between one batch of bodies, such as cylindrical bodies, and another batch of cylindrical bodies.

[0062] Advantageously, the transverse cross-sectional porosity and the cross-sectional porosity distribution value may be determined using a digital imaging process. An image of a transverse cross-section of the core portion may be obtained and a threshold may be applied to differentiate pixels that represent aerosol-forming substrate from pixels that represent void. A porosity of the entire cross-section may then be easily obtained.

[0063] Preferably the cross-sectional porosity distribution value is determined by a method comprising the steps of: obtaining a digital image of a transverse cross-sectional area of the rod, determining the area fraction of voids present within each of a plurality of identically dimensioned sub-areas of the transverse area, thereby obtaining a porosity value for each of the plurality of identically dimensioned sub-areas, and calculating the standard deviation of the porosity values for each of the plurality of identically dimensioned sub-areas. Each sub-area overlaps at least one adjacent sub-area by between 10 percent and 95 percent, preferably by between 75 percent and 85 percent, preferably about 80 percent.

[0064] The core portion is substantially cylindrical and has an average diameter, for example an average diameter of about 4.5 mm. Preferably each of the sub-areas is a rectangle or square having a length of between a quarter and an eighth of the diameter of the core portion, preferably about a sixth or a seventh of the diameter of the core portion. Thus, if the diameter of the core portion is about 4.5 mm, the sub-areas may be squares having sides of about 0.75 mm in length.

[0065] The porosity value of any individual sub-area is preferably only included in the calculation for evaluating porosity distribution if more than 90 percent of that sub-area is within the transverse cross-sectional area of the core portion.

[0066] Preferably the digital image of the transverse cross-sectional area consists of a plurality of pixels, and every pixel making up the transverse cross-sectional area is contained within at least one of the plurality of sub-areas.

[0067] Further details relating to the measurement of cross-sectional porosity and cross-sectional porosity distribution in a porous or air permeable body can be found in the publication of International patent application WO 2016/023965 in the name of the present applicant.

[0068] Preferably, in aerosol-generating articles in accordance with the present invention the core portion has a cross-sectional porosity of at least 0.15. More preferably, in aerosol-generating articles in accordance with the present invention the core portion has a cross-sectional porosity of at least 0.20.

[0069] Preferably, the core portion has a cross-sectional porosity of less than or equal to 0.40. More preferably, the core portion has a cross-sectional porosity of less than or equal to 0.35. Even more preferably, the core portion has a cross-sectional porosity of less than or equal to 0.25.

[0070] In some embodiments, the core portion has a cross-sectional porosity from 0.15 to 0.40, preferably from 0.15 to 0.35, more preferably from 0.15 to 0.25. In other embodiments, the core portion has a cross-sectional porosity from 0.20 to 0.40, preferably from 0.20 to 0.35, more preferably from 0.20 to 0.25.

[0071] The core portion may have a cross-sectional porosity distribution value of at least 0.04, as calculated using the method described above in which each sub-area is a square having a side length of one seventh of the core portion diameter and in which each sub-area overlaps at least one other sub-area by about 80 percent. Preferably, the core portion may have a cross-sectional porosity distribution value of at least 0.10, as calculated using the method described above in which each sub-area is a square having a side length of one seventh of the core portion diameter and in which each sub-area overlaps at least one other sub-area by about 80 percent.

[0072] The core portion may have a cross-sectional porosity distribution value of less than or equal to 0.22, as calculated using the method described above in which each sub-area is a square having a side length of one seventh of the core portion diameter and in which each sub-area overlaps at least one other sub-area by about 80 percent. Preferably, the core portion may have a cross-sectional porosity distribution value of less than or equal to 0.20, as calculated using the method described above in which each sub-area is a square having a side length of one seventh of the core portion diameter and in which each sub-area overlaps at least one other sub-area by about 80 percent. More preferably, the core portion may have a cross-sectional porosity distribution value of less than or equal to 0.15, as calculated using the method described above in which each sub-area is a square having a side length of one seventh of the core portion diameter and in which each sub-area overlaps at least one other sub-area by about 80 percent.

[0073] In some embodiments, the core portion may have a cross-sectional porosity distribution value from 0.04 to 0.22, preferably from 0.04 to 0.20, more preferably from 0.04 to 0.15. In other embodiments, the core portion may have a cross-sectional porosity distribution value from 0.10 to 0.22, preferably from 0.10 to 0.20, more preferably from 0.10 to 0.15. In aerosol-generating articles in accordance with the present invention, an outer diameter of the cylindrical core portion may be at least 1 millimetre. Preferably, an outer diameter of the core portion is at least 3 millimetres. More preferably, an outer diameter of the core portion is at least 3.5 millimetres. An outer diameter of the core portion is preferably less than 8 millimetres. More preferably, an outer diameter of the core portion is less than 7 millimetres. Even more preferably, outer diameter of the core portion is less than 5.75 millimetres.

[0074] In some embodiments, an outer diameter of the core portion is from 3 millimetres to 8 millimetres, preferably from 3 millimetres to 7 millimetres, more preferably from 3 millimetres to 5.75 millimetres. In other embodiments, an outer diameter of the core portion is from 3.5 millimetres to 8 millimetres, preferably from 3.5 millimetres to 7 millimetres, more preferably from 3.5 millimetres to 5.75 millimetres.

[0075] Preferably, a density of the aerosol-generating substrate is at least about 150 mg per cubic centimetre. More preferably, a density of the aerosol-generating substrate is at least about 175 mg per cubic centimetre. More preferably, a density of the aerosol-generating substrate is at least about 200 mg per cubic centimetre. Even more preferably, a density of the aerosol-generating substrate is at least about 250 mg per cubic centimetre. Even more preferably, a density of the aerosol-generating substrate is at least about 300, 400, 500 mg per cubic centimetre. Preferably, a density of the aerosol-generating substrate is less than or equal to about 1500 mg per cubic centimetre. More preferably, a density of the aerosol-generating substrate is less than or equal to about 1000 mg per cubic centimetre. More preferably, a density of the aerosol-generating substrate is less than or equal to about 800 mg per cubic centimetre. Even more preferably, a density of the aerosol-generating substrate is less than or equal to about 700 mg per cubic centimetre.

[0076] For example, a density of the aerosol-generating substrate is preferably from about 150 mg per cubic centimetre to about 1500 mg per cubic centimetre, preferably from about 175 mg per cubic centimetre to about 450 mg per cubic centimetre, more preferably from about 200 mg per cubic centimetre to about 400 mg per cubic centimetre, even more preferably from 250 mg per cubic centimetre to 350 mg per cubic centimetre. In a particularly preferred embodiment of the invention, a density of the aerosol-generating substrate is about 300 mg per cubic centimetre.

[0077] In certain preferred embodiments, the aerosol-generating substrate in the core portion comprises shredded tobacco material, for example tobacco cut filler, having a density of between about 150 mg per cubic centimetre and about 500 mg per cubic centimetre, preferably between about 175 mg per cubic centimetre and about 450 mg per cubic centimetre, more preferably between about 200 mg per cubic centimetre and about 400 mg per cubic centimetre, more preferably between about 250 mg per cubic centimetre and about 350 mg per cubic centimetre, most preferably about 300 mg per cubic centimetre.

[0078] The aerosol-generating substrate may be a solid aerosol-generating substrate. The aerosol-generating substrate preferably comprises an aerosol former. The aerosol former may be any suitable known compound or mixture of compounds that, in use, facilitates formation of a dense and stable aerosol. The aerosol former may be facilitating that the aerosol is substantially resistant to thermal degradation at temperatures typically applied during use of the aerosol-generating article. Suitable aerosol formers are for example: polyhydric alcohols such as, for example, triethylene glycol, 1,3-butanediol, propylene glycol and glycerine; esters of polyhydric alcohols such as, for example, glycerol mono-, di- or triacetate; aliphatic esters of mono-, di- or polycarboxylic acids such as, for example, dimethyl dodecanedioate and dimethyl tetradecanedioate; and combinations thereof.

[0079] Preferably, the aerosol former comprises one or more of glycerine and propylene glycol. The aerosol former

may consist of glycerine or propylene glycol or of a combination of glycerine and propylene glycol.

[0080] Preferably, the aerosol-generating substrate comprises at least 5 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably between 10 percent and 22 percent by weight on a dry weight basis of the cut aerosol-generating substrate, more preferably, the amount of aerosol former is between 12 percent and 19 percent by weight on a dry weight basis of the aerosol-generating substrate, most for example the amount of aerosol former is between 13 percent and 16 percent by weight on a dry weight basis of the aerosol-generating substrate.

[0081] In certain preferred embodiments of the invention, the aerosol-generating substrate comprises shredded tobacco material. For example, the shredded tobacco material may be in the form of cut filler, as described in more detail below. Alternatively, the shredded tobacco material may be in the form of a shredded sheet of homogenised tobacco material. Suitable homogenised tobacco materials for use in the present invention are described below.

[0082] Within the context of the present specification, the term “cut filler” is used to describe to a blend of shredded plant material, such as tobacco plant material, including, in particular, one or more of leaf lamina, processed stems and ribs, homogenised plant material.

[0083] The cut filler may also comprise other after-cut, filler tobacco or casing.

[0084] Preferably, the cut filler comprises at least 25 percent of plant leaf lamina, more preferably, at least 50 percent of plant leaf lamina, still more preferably at least 75 percent of plant leaf lamina and most preferably at least 90 percent of plant leaf lamina. Preferably, the plant material is one of tobacco, mint, tea and cloves. Most preferably, the plant material is tobacco. However, as will be discussed below in greater detail, the invention is equally applicable to other plant material that has the ability to release substances upon the application of heat that can subsequently form an aerosol.

[0085] Preferably, the cut filler comprises tobacco plant material comprising lamina of one or more of bright tobacco, dark tobacco, aromatic tobacco and filler tobacco. With reference to the present invention, the term “tobacco” describes any plant member of the genus *Nicotiana*. Bright tobaccos are tobaccos with a generally large, light coloured leaves. Throughout the specification, the term “bright tobacco” is used for tobaccos that have been flue cured. Examples for bright tobaccos are Chinese Flue-Cured, Flue-Cured Brazil, US Flue-Cured such as Virginia tobacco, Indian Flue-Cured, Flue-Cured from Tanzania or other African Flue Cured. Bright tobacco is characterized by a high sugar to nitrogen ratio. From a sensorial perspective, bright tobacco is a tobacco type which, after curing, is associated with a spicy and lively sensation. Within the context of the present invention, bright tobaccos are tobaccos with a content of reducing sugars of between about 2.5 percent and about 20 percent of dry weight base of the leaf and a total ammonia content of less than about 0.12 percent of dry weight base of the leaf. Reducing sugars comprise for example glucose or fructose. Total ammonia comprises for example ammonia and ammonia salts.

[0086] Dark tobaccos are tobaccos with a generally large, dark coloured leaves. Throughout the specification, the term “dark tobacco” is used for tobaccos that have been air cured.

Additionally, dark tobaccos may be fermented. Tobaccos that are used mainly for chewing, snuff, cigar, and pipe blends are also included in this category. Typically, these dark tobaccos are air cured and possibly fermented. From a sensorial perspective, dark tobacco is a tobacco type which, after curing, is associated with a smoky, dark cigar type sensation. Dark tobacco is characterized by a low sugar to nitrogen ratio. Examples for dark tobacco are Burley Malawi or other African Burley, Dark Cured Brazil Galpao, Sun Cured or Air Cured Indonesian Kasturi. According to the invention, dark tobaccos are tobaccos with a content of reducing sugars of less than about 5 percent of dry weight base of the leaf and a total ammonia content of up to about 0.5 percent of dry weight base of the leaf.

[0087] Aromatic tobaccos are tobaccos that often have small, light coloured leaves. Throughout the specification, the term “aromatic tobacco” is used for other tobaccos that have a high aromatic content, e.g. of essential oils. From a sensorial perspective, aromatic tobacco is a tobacco type which, after curing, is associated with spicy and aromatic sensation. Example for aromatic tobaccos are Greek Oriental, Oriental Turkey, semi-oriental tobacco but also Fire Cured, US Burley, such as Perique, Rustica, US Burley or Meriland. Filler tobacco is not a specific tobacco type, but it includes tobacco types which are mostly used to complement the other tobacco types used in the blend and do not bring a specific characteristic aroma direction to the final product. Examples for filler tobaccos are stems, midrib or stalks of other tobacco types. A specific example may be flue cured stems of Flue Cure Brazil lower stalk.

[0088] The cut filler suitable to be used with the present invention generally may resemble cut filler used for conventional smoking articles. The cut width of the cut filler preferably is between 0.3 millimetres and 2.0 millimetres, more preferably, the cut width of the cut filler is between 0.5 millimetres and 1.2 millimetres and most preferably, the cut width of the cut filler is between 0.6 millimetres and 0.9 millimetres. The cut width may play a role in the distribution of heat inside the rod of aerosol-generating substrate. Also, the cut width may play a role in the resistance to draw of the core portion. Further, the cut width may impact the overall density and cross-sectional porosity of the core portion as a whole.

[0089] The strand length of the cut-filler is to some extent a random value as the length of the strands will depend on the overall size of the object that the strand is cut off from. Nevertheless, by conditioning the material before cutting, for example by controlling the moisture content and the overall subtlety of the material, longer strands can be cut. Preferably, the strands have a length of between about 10 millimetres and about 40 millimetres before the strands are collated to form the rod of aerosol-generating substrate. Obviously, if the strands are arranged in a rod of aerosol-generating substrate in a longitudinal extension where the longitudinal extension of the section is below 40 millimetres, the final core portion of aerosol-generating substrate may comprise strands that are on average shorter than the initial strand length. Preferably, the strand length of the cut-filler is such that between about 20 percent and 60 percent of the strands extend along the full length of the rod of aerosol-generating substrate. This prevents the strands from dislodging easily from the rod of aerosol-generating substrate.

[0090] In preferred embodiments, the weight of the cut filler is between 80 milligrams and 400 milligrams, preferably between 150 milligrams and 250 milligrams, more preferably between 170 milligrams and 220 milligrams. This amount of cut filler typically allows for sufficient material for the formation of an aerosol. Additionally, in the light of the aforementioned constraints on diameter and size, this allows for a balanced density of the core portion comprising the aerosol-generating substrate between energy uptake, resistance to draw and fluid passageways within the rod of aerosol-generating substrate where the aerosol-generating substrate comprises plant material.

[0091] Preferably, the cut filler is soaked with aerosol former. Soaking the cut filler can be done by spraying or by other suitable application methods. The aerosol former may be applied to the blend during preparation of the cut filler. For example, the aerosol former may be applied to the blend in the direct conditioning casing cylinder (DCCC). Conventional machinery can be used for applying an aerosol former to the cut filler. The aerosol former may be any suitable known compound or mixture of compounds that, in use, facilitates formation of a dense and stable aerosol. The aerosol former may be facilitating that the aerosol is substantially resistant to thermal degradation at temperatures typically applied during use of the aerosol-generating article. Suitable aerosol formers are for example to: polyhydric alcohols such as, for example, triethylene glycol, 1,3-butanediol, propylene glycol and glycerine; esters of polyhydric alcohols such as, for example, glycerol mono-, di- or triacetate; aliphatic esters of mono-, di- or polycarboxylic acids such as, for example, dimethyl dodecanedioate and dimethyl tetradecanedioate; and combinations thereof.

[0092] Preferably, the aerosol former comprises one or more of glycerine and propylene glycol. The aerosol former may consist of glycerine or propylene glycol or of a combination of glycerine and propylene glycol.

[0093] Preferably, the amount of aerosol former is at least 5 percent by weight on a dry weight basis, preferably between 10 percent and 22 percent by weight on a dry weight basis of the cut filler, more preferably, the amount of aerosol former is between 12 percent and 19 percent by weight on a dry weight basis of the cut filler, for example the amount of aerosol former is between 13 percent and 16 percent by weight on a dry weight basis of the cut filler. When aerosol former is added to the cut filler in the amounts described above, the cut filler may become relatively sticky. This advantageously help retain the cut filler at a predetermined location within the article, as the particles of cut filler display a tendency to adhere to surrounding cut filler particles as well as to surrounding surfaces (for example, the internal surface of a wrapper circumscribing the cut filler).

[0094] For some embodiments the amount of aerosol former has a target value of about 13 percent by weight on a dry weight basis of the cut filler. The most efficient amount of aerosol former will depend also on the cut filler, whether the cut filler comprises plant lamina or homogenized plant material. For example, among other factors, the type of cut filler will determine to which extent the aerosol-former can facilitate the release of substances from the cut filler.

[0095] For these reasons, a core portion comprising cut filler as described above as the aerosol-generating substrate is capable of efficiently generating sufficient amount of aerosol at relatively low temperatures. A temperature of between 150 degrees Celsius and 200 degrees Celsius in the

heating chamber may be sufficient for one such cut filler to generate sufficient amounts of aerosol while in aerosol-generating devices using tobacco cast leave sheets typically temperatures of about 250 degrees Celsius are employed.

[0096] A further advantage connected with operating at lower temperatures is that there is a reduced need to cool down the aerosol. As generally low temperatures are used, a simpler cooling function may be sufficient. This in turn allows using a simpler and less complex structure of the aerosol-generating article.

[0097] In other preferred embodiments, the aerosol-generating substrate comprises homogenised plant material, preferably a homogenised tobacco material.

[0098] As used herein, the term “homogenised plant material” encompasses any plant material formed by the agglomeration of particles of plant. For example, sheets or webs of homogenised tobacco material for the aerosol-generating substrates of the present invention may be formed by agglomerating particles of tobacco material obtained by pulverising, grinding or comminuting plant material and optionally one or more of tobacco leaf lamina and tobacco leaf stems. The homogenised plant material may be produced by casting, extrusion, paper making processes or other any other suitable processes known in the art.

[0099] The homogenised plant material can be provided in any suitable form.

[0100] In some embodiments, the homogenised plant material may be in the form of one or more sheets. As used herein with reference to the invention, the term “sheet” describes a laminar element having a width and length substantially greater than the thickness thereof.

[0101] The homogenised plant material may be in the form of a plurality of pellets or granules.

[0102] The homogenised plant material may be in the form of a plurality of strands, strips or shreds. As used herein, the term “strand” describes an elongate element of material having a length that is substantially greater than the width and thickness thereof. The term “strand” should be considered to encompass strips, shreds and any other homogenised plant material having a similar form. The strands of homogenised plant material may be formed from a sheet of homogenised plant material, for example by cutting or shredding, or by other methods, for example, by an extrusion method.

[0103] In some embodiments, the strands may be formed in situ within the aerosol-generating substrate as a result of the splitting or cracking of a sheet of homogenised plant material during formation of the aerosol-generating substrate, for example, as a result of crimping. The strands of homogenised plant material within the aerosol-generating substrate may be separate from each other. Alternatively, each strand of homogenised plant material within the aerosol-generating substrate may be at least partially connected to an adjacent strand or strands along the length of the strands. For example, adjacent strands may be connected by one or more fibres. This may occur, for example, where the strands have been formed due to the splitting of a sheet of homogenised plant material during production of the aerosol-generating substrate, as described above.

[0104] Where the homogenised plant material is in the form of one or more sheets, as described above, the sheets may be produced by a casting process. Alternatively, sheets of homogenised plant material may be produced by a paper-making process.

[0105] The one or more sheets as described herein may each individually have a thickness of between 100 micrometres and 600 micrometres, preferably between 150 micrometres and 300 micrometres, and most preferably between 200 micrometres and 250 micrometres. Individual thickness refers to the thickness of the individual sheet, whereas combined thickness refers to the total thickness of all sheets that make up the aerosol-generating substrate. For example, if the aerosol-generating substrate is formed from two individual sheets, then the combined thickness is the sum of the thickness of the two individual sheets or the measured thickness of the two sheets where the two sheets are stacked in the aerosol-generating substrate.

[0106] The one or more sheets as described herein may each individually have a grammage of between about 100 grams per square metre and about 600 grams per square metre.

[0107] The one or more sheets as described herein may each individually have a density of from about 0.3 grams per cubic centimetre to about 1.3 grams per cubic centimetre, and preferably from about 0.7 grams per cubic centimetre to about 1.0 gram per cubic centimetre.

[0108] In embodiments of the present invention in which the aerosol-generating substrate comprises one or more sheets of homogenised plant material, the sheets are preferably in the form of one or more gathered sheets. As used herein, the term “gathered” denotes that the sheet of homogenised plant material is convoluted, folded, or otherwise compressed or constricted substantially transversely to the cylindrical axis of a plug or a rod.

[0109] The one or more sheets of homogenised plant material may be gathered transversely relative to the longitudinal axis thereof and circumscribed with a wrapper to form a continuous rod or a plug.

[0110] The one or more sheets of homogenised plant material may advantageously be crimped or similarly treated. As used herein, the term “crimped” denotes a sheet having a plurality of substantially parallel ridges or corrugations. The one or more sheets of homogenised plant material may be embossed, debossed, perforated or otherwise deformed to provide texture on one or both sides of the sheet.

[0111] Preferably, each sheet of homogenised plant material may be crimped such that it has a plurality of ridges or corrugations substantially parallel to the cylindrical axis of the plug. This treatment advantageously facilitates gathering of the crimped sheet of homogenised plant material to form the plug. Preferably, the one or more sheets of homogenised plant material may be gathered. It will be appreciated that crimped sheets of homogenised plant material may alternatively or in addition have a plurality of substantially parallel ridges or corrugations disposed at an acute or obtuse angle to the cylindrical axis of the plug. The sheet may be crimped to such an extent that the integrity of the sheet becomes disrupted at the plurality of parallel ridges or corrugations causing separation of the material, and results in the formation of shreds, strands or strips of homogenised plant material.

[0112] Alternatively, the one or more sheets of homogenised plant material may be cut into strands as referred to above. In such embodiments, the aerosol-generating substrate comprises a plurality of strands of the homogenised plant material. The strands may be used to form the core portion as a plug. Typically, the width of such strands is

about 5 millimetres, or about 4 millimetres, or about 3 millimetres, or about 2 millimetres or less. The length of the strands may be greater than about 5 millimetres, between about 5 millimetres to about 15 millimetres, about 8 millimetres to about 12 millimetres, or about 12 millimetres. Preferably, the strands have substantially the same length as each other.

[0113] The homogenised plant material may comprise up to about 95 percent by weight of plant particles, on a dry weight basis. Preferably, the homogenised plant material comprises up to about 90 percent by weight of plant particles, more preferably up to about 80 percent by weight of plant particles, more preferably up to about 70 percent by weight of plant particles, more preferably up to about 60 percent by weight of plant particles, more preferably up to about 50 percent by weight of plant particles, on a dry weight basis.

[0114] For example, the homogenised plant material may comprise between about 2.5 percent and about 95 percent by weight of plant particles, or about 5 percent and about 90 percent by weight of plant particles, or between about 10 percent and about 80 percent by weight of plant particles, or between about 15 percent and about 70 percent by weight of plant particles, or between about 20 percent and about 60 percent by weight of plant particles, or between about 30 percent and about 50 percent by weight of plant particles, on a dry weight basis.

[0115] In certain embodiments of the invention, the homogenised plant material is a homogenised tobacco material comprising tobacco particles. Sheets of homogenised tobacco material for use in such embodiments of the invention may have a tobacco content of at least about 40 percent by weight on a dry weight basis, more preferably of at least about 50 percent by weight on a dry weight basis more preferably at least about 70 percent by weight on a dry weight basis and most preferably at least about 90 percent by weight on a dry weight basis.

[0116] With reference to the present invention, the term “tobacco particles” describes particles of any plant member of the genus *Nicotiana*. The term “tobacco particles” encompasses ground or powdered tobacco leaf lamina, ground or powdered tobacco leaf stems, tobacco dust, tobacco fines, and other particulate tobacco by-products formed during the treating, handling and shipping of tobacco. In a preferred embodiment, the tobacco particles are substantially all derived from tobacco leaf lamina. By contrast, isolated nicotine and nicotine salts are compounds derived from tobacco but are not considered tobacco particles for purposes of the invention and are not included in the percentage of particulate plant material.

[0117] The homogenised plant material may further comprise one or more aerosol formers. Upon volatilisation, an aerosol former can convey other vaporised compounds released from the aerosol-generating substrate upon heating, such as nicotine and flavourants, in an aerosol. Suitable aerosol formers for inclusion in the homogenised plant material are known in the art and include, but are not limited to: polyhydric alcohols, such as triethylene glycol, propylene glycol, 1,3-butanediol and glycerol; esters of polyhydric alcohols, such as glycerol mono-, di- or triacetate; and aliphatic esters of mono-, di- or polycarboxylic acids, such as dimethyl dodecanedioate and dimethyl tetradecanedioate.

[0118] The homogenised plant material may have an aerosol former content of between about 5 percent and about 30

percent by weight on a dry weight basis, such as between about 10 percent and about 25 percent by weight on a dry weight basis, or between about 15 percent and about 20 percent by weight on a dry weight basis. The aerosol former may act as a humectant in the homogenised plant material.

[0119] The core portion may comprise a core wrapper circumscribing the aerosol-generating substrate. Thus, the core wrapper is interposed between the aerosol-generating substrate and the annular portion, and an outer surface of the core wrapper effectively defines an outer surface of the core portion. In certain embodiments, wherein the annular portion radially abuts the core portion, the outer surface of the core wrapper abuts an inner surface of the annular portion, and so the core wrapper effectively defines an interface between the core portion and the annular portion.

[0120] In turn, the aerosol-generating rod as a whole may comprise a rod wrapper circumscribing the annular portion. Thus, an outer surface of the rod wrapper defines an outer surface of the aerosol-generating rod.

[0121] The core wrapper circumscribing the aerosol-generating substrate may be a paper wrapper or a non-paper wrapper. Equally, the rod wrapper circumscribing the annular portion may be a paper wrapper or a non-paper wrapper.

[0122] The core wrapper may have an air permeability of less than 1000 CORESTA units. In certain preferred embodiments, the core wrapper has an air permeability of less than or equal to 100 CORESTA units. More preferably, the core wrapper has an air permeability of less than or equal to 80 CORESTA units. Even more preferably, the core wrapper has an air permeability of less than or equal to 60 CORESTA units.

[0123] The core wrapper may have an air permeability of at least 5 CORESTA units. Preferably, the core wrapper has an air permeability of at least 10 CORESTA units. More preferably, the core wrapper has an air permeability of at least 20 CORESTA units.

[0124] In certain embodiments, the core wrapper has an air permeability from 5 CORESTA units to 100 CORESTA units, preferably from 5 CORESTA units to 80 CORESTA units, more preferably from 5 CORESTA units to 60 CORESTA units. In other embodiments, the core wrapper has an air permeability from 10 CORESTA units to 100 CORESTA units, preferably from 10 CORESTA units to 80 CORESTA units, more preferably from 10 CORESTA units to 60 CORESTA units. In further embodiments, the core wrapper has an air permeability from 20 CORESTA units to 100 CORESTA units, preferably from 20 CORESTA units to 80 CORESTA units, more preferably from 20 CORESTA units to 60 CORESTA units.

[0125] The provision of a core wrapper having an air permeability within the preferred ranges described above hinders and may substantially prevent radial airflow across the core wrapper, such that airflow from the core portion into the annular portion and vice-versa is substantially impeded.

[0126] This may advantageously enhance the technical benefit associated with the invention and described above, because, when the aerosol-generating article is not paired with an aerosol-generating device or when the aerosol-generating article is paired with the wrong aerosol-generating device, a low-permeability core wrapper will substantially prevent side airflow from the annular portion into the core portion, and so substantially all the air drawn into the annular portion will flow longitudinally through the annular portion from one end to the other. Thus, a low-permeability

core wrapper acts in synergy with the substantial difference in cross-sectional porosity and relative arrangement of core portion and annular portion.

[0127] Suitable paper wrappers for use in specific embodiments of the invention are known in the art and include, but are not limited to: cigarette papers; and filter plug wraps. Suitable non-paper wrappers for use in specific embodiments of the invention are known in the art and include, but are not limited to sheets of homogenised tobacco materials. In the following, the features of suitable paper and non-paper wrappers will be discussed in more detail. The paper and non-paper wrappers described below may be used as the core wrapper or as the rod wrapper or both.

[0128] A paper wrapper may have a grammage of at least 15 gsm, preferably at least 20 gsm. The paper wrapper may have a grammage of less than or equal to 35 gsm, preferably less than or equal to 30 gsm. The paper wrapper may have a grammage from 15 gsm to 35 gsm, preferably from 20 gsm to 30 gsm. In a preferred embodiment, the paper wrapper may have a grammage of 25 gsm. A paper wrapper may have a thickness of at least 25 micrometres, preferably at least 30 micrometres, more preferably at least 35 micrometres. The paper wrapper may have a thickness of less than or equal to 55 micrometres, preferably less than or equal to 50 micrometres, more preferably less than or equal to 45 micrometres. The paper wrapper may have a thickness from 25 micrometres to 55 micrometres, preferably from 30 micrometres to 50 micrometres, more preferably from 35 micrometres to 45 micrometres. In a preferred embodiment, the paper wrapper may have a thickness of 40 microns.

[0129] In certain preferred embodiments, the wrapper may be formed of a laminate material comprising a plurality of layers. Preferably, the wrapper is formed of an aluminium co-laminated sheet. The use of a co-laminated sheet comprising aluminium advantageously prevents combustion of the aerosol-generating substrate in the event that the aerosol-generating substrate should be ignited, rather than heated in the intended manner.

[0130] A paper layer of the co-laminated sheet may have a grammage of at least 35 gsm, preferably at least 40 gsm. The paper layer of the co-laminated sheet may have a grammage of less than or equal to 55 gsm, preferably less than or equal to 50 gsm. The paper layer of the co-laminated sheet may have a grammage from 35 gsm to 55 gsm, preferably from 40 gsm to 50 gsm. In a preferred embodiment, the paper layer of the co-laminated sheet may have a grammage of 45 gsm.

[0131] A paper layer of the co-laminated sheet may have a thickness of at least 50 micrometres, preferably at least 55 micrometres, more preferably at least 60 micrometres. The paper layer of the co-laminated sheet may have a thickness of less than or equal to 80 micrometres, preferably less than or equal to 75 micrometres, more preferably less than or equal to 70 micrometres.

[0132] The paper layer of the co-laminated sheet may have a thickness from 50 micrometres to 80 micrometres, preferably from 55 micrometres to 75 micrometres, more preferably from 60 micrometres to 70 micrometres. In a preferred embodiment, the paper layer of the co-laminated sheet may have a thickness of 65 microns.

[0133] A metallic layer of the co-laminated sheet may have a grammage of at least 12 gsm, preferably at least 15 gsm. The metallic layer of the co-laminated sheet may have a grammage of less than or equal to 25 gsm, preferably less

than or equal to 20 gsm. The metallic layer of the co-laminated sheet may have a grammage from 12 gsm to 25 gsm, preferably from 15 gsm to 20 gsm. In a preferred embodiment, the metallic layer of the co-laminated sheet may have a grammage of 17 gsm.

[0134] A metallic layer of the co-laminated sheet may have a thickness of at least 2 micrometres, preferably at least 3 micrometres, more preferably at least 5 micrometres. The metallic layer of the co-laminated sheet may have a thickness of less than or equal to 15 micrometres, preferably less than or equal to 12 micrometres, more preferably less than or equal to 10 micrometres.

[0135] The metallic layer of the co-laminated sheet may have a thickness from 2 micrometres to 15 micrometres, preferably from 3 micrometres to 12 micrometres, more preferably from 5 micrometres to 10 micrometres. In a preferred embodiment, the metallic layer of the co-laminated sheet may have a thickness of 6 microns.

[0136] The wrapper, and particularly the rod wrapper, may be a paper wrapper comprising PVOH (polyvinyl alcohol) or silicon. Addition of PVOH (polyvinyl alcohol) or silicon may improve the grease barrier properties of the wrapper.

[0137] The PVOH or silicon may be applied to the paper layer as a surface coating, such as disposed on an exterior surface of the paper layer of the wrapper circumscribing the aerosol-generating rod. The PVOH or silicon may be disposed on and form a layer on the exterior surface of the paper layer of the wrapper. The PVOH or silicon may be disposed on an interior surface of the paper layer of the wrapper. The PVOH or silicon may be disposed on and form a layer on the interior surface of the paper layer of the aerosol generating article. The PVOH or silicon may be disposed on the interior surface and the exterior surface of the paper layer of the wrapper. The PVOH or silicon may be disposed on and form a layer on the interior surface and the exterior surface of the paper layer of the wrapper.

[0138] The paper wrapper comprising PVOH or silicon may have a grammage of at least 20 gsm, preferably at least 25 gsm, more preferably at least 30 gsm. The paper wrapper comprising PVOH or silicon may have a grammage of less than or equal to 50 gsm, preferably less than or equal to 45 gsm, more preferably less than or equal to 40 gsm. The paper wrapper comprising PVOH or silicon may have a grammage from 20 gsm to 50 gsm, preferably from 25 gsm to 45 gsm, more preferably from 30 gsm to 40 gsm. In particularly preferred embodiments, the paper wrapper comprising PVOH or silicon may have a grammage of about 35 gsm.

[0139] The paper wrapper comprising PVOH or silicon may have a thickness of at least 25 micrometres, preferably at least 30 micrometres, more preferably at least 35 micrometres. The paper wrapper comprising PVOH or silicon may have a thickness of less than or equal to 50 micrometres, preferably less than or equal to 45 micrometres, more preferably less than or equal to 40 micrometres. The paper wrapper comprising PVOH or silicon may have a thickness from 25 micrometres to 50 micrometres, preferably from 30 micrometres to 45 micrometres, more preferably from 35 micrometres to 40 micrometres. In particularly preferred embodiments, the paper wrapper comprising PVOH or silicon may have a thickness of 37 micrometres.

[0140] The wrapper, and particularly the core wrapper, may comprise a flame retardant composition comprising one or more flame retardant compounds. The term "flame retardant compounds" is used herein to describe chemical com-

pounds that, when added to or otherwise incorporated into a carrier substrate, such as paper or plastic compounds, provide the carrier substrate with varying degrees of flammability protection. In practice, flame retardant compounds may be activated by the presence of an ignition source and are adapted to prevent or slow the further development of ignition by a variety of different physical and chemical mechanisms.

[0141] A flame retardant composition may typically further comprise one or more non-flame retardant compounds, that is, one or more compound—such as a solvent, an excipient, a filler—that does not actively contribute to providing the carrier substrate with flammability protection, but is used to facilitate the application of the flame retardant compound or compounds onto or into the wrapper or both. Some of the non-flame retardant compounds of a flame retardant composition—such as solvents—are volatile and may evaporate from the wrapper upon drying after the flame retardant composition has been applied onto or into the wrapping base material or both. As such, although such non-flame retardant compounds form part of the formulation of the flame retardant composition, they may no longer be present or they may only be detectable in trace amounts in the wrapper of an aerosol-generating article.

[0142] A number of suitable flame retardant compounds are known to the skilled person. In particular, several flame retardant compounds and formulations suitable for treating cellulosic materials are known and have been disclosed and may find use in the manufacture of wrappers for aerosol-generating articles in accordance with the present invention.

[0143] For example, the flame retardant composition may comprise a polymer and a mixed salt based on at least one mono, di- and/or tri-carboxylic acid, at least one polyphosphoric, pyrophosphoric and/or phosphoric acid, and a hydroxide or a salt of an alkali or an alkaline earth metal, where the at least one mono, di- and/or tri-carboxylic acid and the hydroxide or salt form a carboxylate and the at least one polyphosphoric, pyrophosphoric and/or phosphoric acid and the hydroxide or salt form a phosphate. Preferably, the flame retardant composition may further comprise a carbonate of an alkali or an alkaline earth metal. Alternatively, the flame retardant composition may comprise cellulose modified with at least one C10 or higher fatty acid, tall oil fatty acid (TOFA), phosphorylated linseed oil, phosphorylated downstream corn oil. Preferably, the at least one C10 or higher fatty acid is selected from the group consisting of capric acid, myristic acid, palmitic acid, and combinations thereof.

[0144] In a wrapper comprising a flame retardant composition suitable for use in an aerosol-generating article in accordance with the present invention, the flame retardant composition may be provided in a treated portion of the wrapper. This means that the flame retardant composition has been applied onto or into a corresponding portion of a wrapping base material of the wrapper or both. Thus, in the treated portion, the wrapper has an overall dry basis weight that is greater than the dry basis weight of the wrapping base material. The treated portion of the wrapper may extend over at least about 10 percent of an outer surface area of the core portion circumscribed by the wrapper, preferably over at least about 20 percent of an outer surface area of the core portion circumscribed by the wrapper, more preferably over at least about 40 percent of an outer surface area of the core portion, even more preferably over at least about 60 percent

of an outer surface area of the core portion. Most preferably, the treated portion of the wrapper extends over at least about 80 percent of an outer surface area of the core portion. In particularly preferred embodiments, the treated portion of the wrapper extends over at least about 90 or even 95 percent of an outer surface area of the core portion. Most preferably, the treated portion of the wrapper extends substantially over the entire outer surface area of the core portion.

[0145] The wrapper comprising a flame retardant composition may have a grammage of at least 20 gsm, preferably at least 25 gsm, more preferably at least 30 gsm. The wrapper comprising a flame retardant composition may have a grammage of less than or equal to 45 gsm, preferably less than or equal to 40 gsm, more preferably less than or equal to 35 gsm. The wrapper comprising a flame retardant composition may have a grammage from 20 gsm to 45 gsm, preferably from 25 gsm to 40 gsm, more preferably from 30 gsm to 35 gsm. In some preferred embodiments, the wrapper comprising a flame retardant composition may have a grammage of 33 gsm.

[0146] The wrapper comprising a flame retardant composition may have a thickness of at least 25 micrometres, preferably at least 30 micrometres, even more preferably 35 micrometres. The wrapper comprising a flame retardant composition may have a thickness of less than or equal to 50 micrometres, preferably less than or equal to 45 micrometres, even more preferably less than or equal to 40 micrometres. In some embodiments, the wrapper comprising a flame retardant composition may have a thickness of 37 micrometres.

[0147] In some embodiments, the aerosol-generating article may comprise a susceptor element arranged within the core portion and thermally coupled with the aerosol-generating substrate. As used herein, the term “susceptor element” refers to an element comprising a material that is capable of converting electromagnetic energy into heat. When a susceptor element is located in an alternating electromagnetic field, the susceptor is heated. Heating of the susceptor element may be the result of at least one of hysteresis losses and eddy currents induced in the susceptor, depending on the electrical and magnetic properties of the susceptor material.

[0148] In aerosol-generating articles in accordance with the present invention, the annular portion advantageously separates a susceptor element provided within the core portion from a periphery of the aerosol-generating article—for example, from the core wrapper. This is beneficial in that accidental self-ignition of the aerosol-generating article due to a direct cooperation between a core wrapper containing paper and a misaligned susceptor element may be prevented. Additionally, during or immediately after use, the annular portion may act as an insulating barrier between a hot surface of the susceptor element and the consumer.

[0149] The provision of a susceptor element provided within the core portion also has the benefit that the heat source is internal to the core portion. On the other hand, external heating—that is, supplying heat by way of a heating element arranged outside of the aerosol-generating article—would be less efficient as the annular portion may act as a thermal insulation barrier.

[0150] A susceptor element may be arranged such that, when the aerosol-generating article is received in the cavity of the aerosol-generating device, the oscillating electromagnetic field generated by the inductor coil induces a current in

the susceptor element, causing the susceptor element to heat up. In these embodiments, the aerosol-generating device is preferably capable of generating a fluctuating electromagnetic field having a magnetic field strength (H-field strength) of between 1 and 5 kilo amperes per metre (kA m), preferably between 2 and 3 kA/m, for example about 2.5 kA/m. The electrically-operated aerosol-generating device is preferably capable of generating a fluctuating electromagnetic field having a frequency of between 1 and 30 MHz, for example between 1 and 10 MHz, for example between 5 and 7 MHz.

[0151] The susceptor element may comprise any suitable material. The susceptor element may be formed from any material that can be inductively heated to a temperature sufficient to release volatile compounds from the aerosol-forming substrate. Suitable materials for the elongate susceptor element include graphite, molybdenum, silicon carbide, stainless steels, niobium, aluminium, nickel, nickel containing compounds, titanium, and composites of metallic materials. Some susceptor elements comprise a metal or carbon. Advantageously the susceptor element may comprise or consist of a ferromagnetic material, for example, ferritic iron, a ferromagnetic alloy, such as ferromagnetic steel or stainless steel, ferromagnetic particles, and ferrite. A suitable susceptor element may be, or comprise, aluminium. The susceptor element preferably comprises more than about 5 percent, preferably more than about 20 percent, more preferably more than about 50 percent or more than about 90 percent of ferromagnetic or paramagnetic materials. Some elongate susceptor elements may be heated to a temperature in excess of about 250 degrees Celsius.

[0152] The susceptor element may comprise a non-metallic core with a metal layer disposed on the non-metallic core. For example, the susceptor element may comprise metallic tracks formed on an outer surface of a ceramic core or substrate.

[0153] In some embodiments the aerosol-generating device may comprise at least one resistive heating element and at least one inductive heating element. In some embodiments the aerosol-generating device may comprise a combination of resistive heating elements and inductive heating elements.

[0154] During use, the heater may be controlled to operate within a defined operating temperature range, below a maximum operating temperature. An operating temperature range between about 150 degrees Celsius and about 300 degrees Celsius in the heating chamber (or device cavity) is preferable. The operating temperature range of the heater may be between about 150 degrees Celsius and about 250 degrees Celsius.

[0155] Preferably, the operating temperature range of the heater may be between about 150 degrees Celsius and about 200 degrees Celsius. More preferably, the operating temperature range of the heater may be between about 180 degrees Celsius and about 200 degrees Celsius. In particular, it has been found that optimal and consistent aerosol delivery may be achieved when using an aerosol-generating device having an external heater, which has an operating temperature range between about 180 degrees Celsius and about 200 degrees Celsius, with aerosol-generating articles having a relatively low RTD (for example, with a downstream section RTD of less than 15 mm H₂O), as mentioned in the present disclosure.

[0156] The susceptor element may be in the form of an elongate susceptor arranged longitudinally within the aerosol-generating substrate. When used for describing the susceptor element, the term “elongate” means that the susceptor element has a length dimension that is greater than its width dimension or its thickness dimension, for example greater than twice its width dimension or its thickness dimension.

[0157] The susceptor may be arranged substantially longitudinally within the core portion. This means that the length dimension of the elongate susceptor is arranged to be approximately parallel to the longitudinal direction of the aerosol-generating rod, for example within plus or minus 10 degrees of parallel to the longitudinal direction of the aerosol-generating rod. In preferred embodiments, the elongate susceptor may be positioned in a radially central position within the aerosol-generating rod, and extends along the longitudinal axis of the aerosol-generating rod.

[0158] In particularly preferred embodiments, the susceptor has substantially the same length as the aerosol-generating rod, and extends from the upstream end of the core portion to the downstream end of the core portion. The susceptor is preferably in the form of a pin, rod, strip or blade.

[0159] If the susceptor has the form of a strip or blade, the strip or blade preferably has a rectangular shape having a width of preferably from 2 millimetres to 6 millimetres, more preferably from 2.5 millimetres to 5.5 millimetres, even more preferably from 3 millimetres to 5 millimetres. By way of example, a susceptor in the form of a strip or blade may have a width of about 3.75 millimetres.

[0160] In a preferred embodiment, the elongate susceptor is in the form of a strip or blade, has a substantially rectangular shape, and a thickness from about 55 micrometres to about 65 micrometres.

[0161] In aerosol-generating articles in accordance with the present invention, the aerosol-generating rod further comprises an air permeable annular portion that surrounds and extends coaxially with the core portion. The annular portion extends radially from an internal periphery of the annular portion to an outer periphery of the annular portion. A distance between the internal periphery of the annular portion and the outer periphery of the annular portion measured along the radial direction may be described as a thickness of the annular portion.

[0162] Preferably, the annular portion has a substantially uniform cross-section along the length of the aerosol-generating rod. Particularly preferably, the cross-section of the annular portion is the region comprised between two concentric circles defined by the intersection of an outer periphery and an inner periphery of the annular portion with a transverse plane, wherein the radii of the two concentric circles remain substantially constant along the length of the aerosol-generating rod. As such, a thickness of the annular portion is preferably substantially constant along the length of the aerosol-generating rod.

[0163] Preferably, the annular portion and the core portion are of the same length.

[0164] A cross-sectional porosity of the annular portion is at least 120 percent of the cross-sectional porosity of the core portion. Preferably, a cross-sectional porosity of the annular portion is at least 130 percent of the cross-sectional porosity of the core portion. More preferably, a cross-sectional porosity of the annular portion is at least 140 percent of the cross-sectional porosity of the core portion.

Even more preferably, a cross-sectional porosity of the annular portion is at least 150 percent of the cross-sectional porosity of the core portion.

[0165] In some embodiments, a cross-sectional porosity of the annular portion may be at least 175 percent of the cross-sectional porosity of the core portion, preferably at least 200 percent of the cross-sectional porosity of the core portion.

[0166] In certain embodiments, a cross-sectional porosity of the annular portion may be at least 200 percent of the cross-sectional porosity of the core portion, preferably at least 250 percent of the cross-sectional porosity of the core portion, more preferably at least 300 percent of the cross-sectional porosity of the core portion, even more preferably 400 percent of the cross-sectional porosity of the core portion or 500 percent of the cross-sectional porosity of the core portion or 600 percent of the cross-sectional porosity of the core portion.

[0167] In some embodiments, a cross-sectional porosity of the annular portion may be from 120 percent to 600 percent of the cross-sectional porosity of the core portion or from 120 percent to 500 percent of the cross-sectional porosity of the core portion or from 120 percent to 400 percent of the cross-sectional porosity of the core portion or from 120 percent to 300 percent of the cross-sectional porosity of the core portion or from 120 percent to 200 percent of the cross-sectional porosity of the core portion.

[0168] In other embodiments, a cross-sectional porosity of the annular portion may be from 130 percent to 600 percent of the cross-sectional porosity of the core portion or from 130 percent to 500 percent of the cross-sectional porosity of the core portion or from 130 percent to 400 percent of the cross-sectional porosity of the core portion or from 130 percent to 300 percent of the cross-sectional porosity of the core portion or from 130 percent to 200 percent of the cross-sectional porosity of the core portion.

[0169] In further embodiments, a cross-sectional porosity of the annular portion may be from 140 percent to 600 percent of the cross-sectional porosity of the core portion or from 140 percent to 500 percent of the cross-sectional porosity of the core portion or from 140 percent to 400 percent of the cross-sectional porosity of the core portion or from 140 percent to 300 percent of the cross-sectional porosity of the core portion or from 140 percent to 200 percent of the cross-sectional porosity of the core portion.

[0170] In yet further embodiments, a cross-sectional porosity of the annular portion may be from 150 percent to 600 percent of the cross-sectional porosity of the core portion or from 150 percent to 500 percent of the cross-sectional porosity of the core portion or from 150 percent to 400 percent of the cross-sectional porosity of the core portion or from 150 percent to 300 percent of the cross-sectional porosity of the core portion or from 150 percent to 200 percent of the cross-sectional porosity of the core portion.

[0171] A cross-sectional porosity of the annular portion may be up to 0.99.

[0172] Preferably, a cross-section porosity of the annular portion is less than 0.95. More preferably, a cross-section porosity of the annular portion is less than 0.90. Even more preferably, a cross-section porosity of the annular portion is less than 0.85. This is beneficial in that it may ensure a certain structural strength of the annular portion and of the rod as a whole.

[0173] A cross-sectional porosity of the annular portion may be at least 0.3. Preferably, a cross-sectional porosity of the annular portion is at least 0.35. More preferably, a cross-sectional porosity of the annular portion is at least 0.4. Even more preferably, a cross-sectional porosity of the annular portion is at least 0.45.

[0174] In some embodiments, a cross-sectional porosity of the annular portion is from 0.3 to 0.95, preferably from 0.35 to 0.95, more preferably from 0.4 to 0.95, even more preferably from 0.5 to 0.95. In other embodiments, a cross-sectional porosity of the annular portion is from 0.3 to 0.90, preferably from 0.35 to 0.90, more preferably from 0.4 to 0.90, even more preferably from 0.5 to 0.90. In further embodiments, a cross-sectional porosity of the annular portion is from 0.3 to 0.85, preferably from 0.35 to 0.85, more preferably from 0.4 to 0.85, even more preferably from 0.5 to 0.85.

[0175] By virtue of such low porosity values, the annular portion presents a resistance to draw (RTD) that is significantly lower than an RTD of the core portion.

[0176] In aerosol-generating articles in accordance with the present invention, an RTD of the annular portion is preferably less than 65 millimetres H₂O. More preferably, an RTD of the annular portion is preferably less than 60 millimetres H₂O. Even more preferably, an RTD of the annular portion is preferably less than 55 millimetres H₂O.

[0177] An RTD of the annular portion may be at least 5 millimetres H₂O. Preferably, an RTD of the annular portion is at least 10 millimetres H₂O. More preferably, an RTD of the annular portion is at least 20 millimetres H₂O. Even more preferably, an RTD of the annular portion is at least 30 millimetres H₂O.

[0178] In some embodiments, an RTD of the annular portion is from 10 millimetres H₂O to 65 millimetres H₂O, preferably from 10 millimetres H₂O to 60 millimetres H₂O, more preferably from 10 millimetres H₂O to 55 millimetres H₂O. In other embodiments, an RTD of the annular portion is from 20 millimetres H₂O to 65 millimetres H₂O, preferably from 20 millimetres H₂O to 60 millimetres H₂O, more preferably from 20 millimetres H₂O to 55 millimetres H₂O. In further embodiments, an RTD of the annular portion is from 30 millimetres H₂O to 65 millimetres H₂O, preferably from 30 millimetres H₂O to 60 millimetres H₂O, more preferably from 30 millimetres H₂O to 55 millimetres H₂O.

[0179] The annular portion may comprise a porous material, such as for example a foam or a fibrous material, such as a non-woven material.

[0180] The annular portion may comprise a fibrous material. In some embodiments, the annular portion comprises a plurality of fibres, preferably linear and axially oriented fibres. As used herein, the expression “linear and axially oriented fibres” is used to describe a plurality of fibres that are substantially aligned with one another along an axial direction, or aerosol draw direction, of the annular portion. This is in contrast to multidirectional or random or multidirectional and random oriented fibres, that is, in contrast to a plurality of fibres which are predominantly misaligned, having a plurality of different or random or different and random orientations, including both parallel and perpendicular with respect to the axial or aerosol draw direction.

[0181] Suitable fibres will be known to the skilled person. Preferably, the annular portion comprises fibres selected from: cellulose acetate fibres, poly lactic acid (PLA) fibres, polypropylene fibres, poly(3-hydroxybutyrate-co-hydroxy-

valerate) (PHVB) fibres, rayon fibres, viscose fibres, regenerated cellulose fibres, and combinations thereof.

[0182] In certain embodiments, the annular portion may comprise two or more longitudinal segments of tow material, and the tow material of adjacent ones of the two or more longitudinal segments is bonded together at least along longitudinal edges of the segments to form an integral annular portion. At least two or all of the segments may be formed from the same tow.

[0183] Preferably, the annular portion comprises fibres having a denier per filament (dpf) of at least 3.0. More preferably, the annular portion comprises fibres having a dpf of at least 5.0. More preferably, the annular portion comprises fibres having a dpf of at least 6.0.

[0184] Preferably, the annular portion comprises fibres having a dpf of less than or equal to 15.0. More preferably, the annular portion comprises fibres having a dpf of less than or equal to 10.0. Even more preferably, the annular portion comprises fibres having a dpf of less than or equal to 9.0.

[0185] In some embodiments, the annular portion comprises fibres having a dpf of from 3.0 to 15.0, preferably from 3.0 to 10.0, more preferably from 3.0 to 9.0. In other embodiments, the annular portion comprises fibres having a dpf of from 5.0 to 15.0, preferably from 5.0 to 10.0, more preferably from 5.0 to 9.0. In further embodiments, the annular portion comprises fibres having a dpf of from 6.0 to 15.0, preferably from 6.0 to 10.0, more preferably from 6.0 to 9.0.

[0186] In some embodiments, the fibres may have a Y-shaped cross-section.

[0187] An outer diameter of the annular portion may be up to 10 millimetres. Preferably, an outer diameter of the annular portion is less than 9 millimetres. More preferably, an outer diameter of the annular portion is less than 7.7 millimetres.

[0188] In aerosol-generating articles in accordance with the present invention, a thickness of the annular portion may be at least 0.5 millimetres. Preferably, a thickness of the annular portion is at least 1.0 millimetres. More preferably, a thickness of the annular portion is at least 1.5 millimetres. A thickness of the annular portion may be less than 5.0 millimetres. Preferably, a thickness of the annular portion is less than 4.0 millimetres. More preferably, a thickness of the annular portion is less than 3.5 millimetres. Even more preferably, a thickness of the annular portion is less than 3.0 millimetres.

[0189] In some embodiments, a thickness of the annular portion is from 0.5 millimetres to 4 millimetres, preferably from 0.5 millimetres to 3.5 millimetres, more preferably from 0.5 millimetres to 3 millimetres. In other embodiments, a thickness of the annular portion is from 1.0 millimetres to 4 millimetres, preferably from 1.0 millimetres to 3.5 millimetres, more preferably from 1.0 millimetres to 3 millimetres. In further embodiments, a thickness of the annular portion is from 1.5 millimetres to 4 millimetres, preferably from 1.5 millimetres to 3.5 millimetres, more preferably from 1.5 millimetres to 3 millimetres.

[0190] In preferred embodiments, the annular portion radially abuts the core portion. In other words, the annular portion immediately circumscribes the core portion. In these embodiments, an inner periphery of the annular portion is immediately adjacent an outer periphery of the cylindrical core portion, for example as defined by an outer surface of the core wrapper, and the annular portion thus extends

radially from the outer periphery of the cylindrical core portion to the outer periphery of the annular portion. Thus, an internal diameter of the annular portion substantially matches the outer diameter of the core portion.

[0191] As described briefly above, an aerosol-generating article in accordance with the present invention comprises a downstream section provided downstream of the aerosol-generating rod and abutting the downstream end of the aerosol-generating rod.

[0192] The downstream section may have any length. The downstream section may have a length of at least 10 millimetres. For example, the downstream section may have a length of at least 15 millimetres, at least 20 millimetres, at least 25 millimetres, or at least 30 millimetres.

[0193] The provision of a downstream section having a length greater than the values set out above may advantageously provide space for the aerosol to cool and condense before reaching the consumer. This may also ensure a user is spaced apart from the heating element when the aerosol-generating article is used in conjunction with an aerosol generating device.

[0194] The downstream section may have a length of no more than 80 millimetres. For example, the downstream section may have a length of no more than 70 millimetres, no more than 60 millimetres, no more than 50 millimetres, or no more than 40 millimetres.

[0195] A ratio between the length of the downstream section and the length of the aerosol-generating rod may be from 1.0 to 4.5. Preferably, a ratio between the length of the downstream section and the length of the aerosol-generating rod is at least 1.25, more preferably at least 1.5, even more preferably at least 2.0. In preferred embodiments, a ratio between the length of the downstream section and the length of the aerosol-generating rod is less than or equal to 4.0, preferably less than 3.5, even more preferably less than 3.0.

[0196] A length of the downstream section substantially corresponds to the sum of the lengths of the individual components forming the downstream section.

[0197] In preferred embodiments, the downstream section comprises a hollow tubular element. The hollow tubular element defines an internal cavity, and an upstream end of the hollow tubular element abuts the downstream end of the aerosol-generating rod. In such embodiments, an internal diameter of the annular portion is preferably smaller than an internal diameter of the hollow tubular element, such that the annular portion is in direct fluid communication with the internal cavity of the hollow tubular element.

[0198] In aerosol-generating articles in accordance with the present invention, a length of the hollow tubular element may be at least 5 millimetres. Preferably, a length of the hollow tubular element is at least 10 millimetres. More preferably, a length of the hollow tubular element is at least 12 millimetres. Even more preferably, a length of the hollow tubular element is at least 15 millimetres.

[0199] Preferably, a length of the hollow tubular element is less than or equal to 45 millimetres. More preferably, a length of the hollow tubular element is less than or equal to 40 millimetres. Even more preferably, a length of the hollow tubular element is less than or equal to 40 millimetres.

[0200] In preferred embodiments, a length of the hollow tubular element is less than or equal to 35 millimetres. More preferably, a length of the hollow tubular element is less than or equal to 30 millimetres. Even more preferably, a length of the hollow tubular element is less than or equal to 25

millimetres. In particularly preferred embodiments, a length of the hollow tubular element is less than or equal to 22 millimetres.

[0201] In some embodiments, a length of the hollow tubular element is from 10 millimetres to 45 millimetres, preferably from 10 millimetres to 40 millimetres, more preferably from 10 millimetres to 35 millimetres, even more preferably from 10 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the hollow tubular element is from 10 millimetres to 25 millimetres, preferably from 10 millimetres to 22 millimetres.

[0202] In other embodiments, a length of the hollow tubular element is from 12 millimetres to 45 millimetres, preferably from 12 millimetres to 40 millimetres, more preferably from 12 millimetres to 35 millimetres, even more preferably from 12 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the hollow tubular element is from 12 millimetres to 25 millimetres, preferably from 12 millimetres to 22 millimetres.

[0203] In further embodiments, a length of the hollow tubular element is from 15 millimetres to 45 millimetres, preferably from 15 millimetres to 40 millimetres, more preferably from 15 millimetres to 35 millimetres, even more preferably from 15 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the hollow tubular element is from 15 millimetres to 25 millimetres, preferably from 15 millimetres to 22 millimetres.

[0204] The hollow tubular element may have an internal diameter of at least 3.5 millimetres. For example, the hollow tubular element may have an internal diameter of at least 4 millimetres, at least 5 millimetres, or at least 6 millimetres.

[0205] The provision of a hollow tubular element having an internal diameter as set out above may advantageously provide sufficient rigidity and strength to the hollow tubular element.

[0206] The hollow tubular element may have an internal diameter of no more than 7 millimetres. For example, the hollow tubular element may have an internal diameter of no more than about 6.5 millimetres.

[0207] The provision of a hollow tubular element having an internal diameter as set out above may advantageously reduce the resistance to draw of the hollow tubular element.

[0208] The hollow tubular element may have an internal diameter of between 3.5 millimetres and 7 millimetres, between 4 millimetres and 7 millimetres, between about 5 millimetres and 7 millimetres, or between 6 millimetres and 7 millimetres. The hollow tubular element may have an internal diameter of between 3.5 millimetres and 6.5 millimetres, between 4 millimetres and 6.5 millimetres, between about 5 millimetres and 6.5 millimetres, or between 6 millimetres and 6.5 millimetres.

[0209] An outer diameter of the hollow tubular element preferably substantially matches the outer diameter of the annular portion. This may also be approximately equal to the outer diameter of the aerosol-generating article.

[0210] A ratio between an internal diameter of the hollow tubular element and an external diameter of the hollow tubular element may be at least about 0.8. For example, the ratio between an internal diameter of the hollow tubular element and the external diameter of the hollow tubular element may be at least about 0.85, at least about 0.9, or at least about 0.95.

[0211] The ratio between an internal diameter of the hollow tubular element and the external diameter of the

hollow tubular element may be no more than about 0.99. For example, the ratio between an internal diameter of the hollow tubular element and the external diameter of the hollow tubular element may be no more than about 0.98.

[0212] The ratio between an internal diameter of the hollow tubular element and the external diameter of the hollow tubular element may be about 0.97.

[0213] The provision of relatively large internal diameter may advantageously reduce the resistance to draw of the hollow tubular element.

[0214] The lumen of the hollow tubular element may have any cross sectional shape. The lumen of the hollow tubular element may have a circular cross sectional shape.

[0215] The hollow tubular element may be formed from any material. For example, the hollow tubular element may comprise cellulose acetate tow. Where the hollow tubular element comprises cellulose acetate tow, the hollow tubular element may have a thickness of between about 0.1 millimetre and about 1 millimetre. The hollow tubular element may have a thickness of about 0.5 millimetres.

[0216] Where the hollow tubular element comprises cellulose acetate tow, the cellulose acetate tow may have a dpf of between about 2 and about 4 and a total denier of between about 25 and about 40.

[0217] The hollow tubular element may comprise paper. The hollow tubular element may comprise at least one layer of paper. The paper may be very rigid paper. The paper may be crimped paper, such as crimped heat resistant paper or crimped parchment paper. The paper may be cardboard. The hollow tubular element may be a paper tube. The hollow tubular element may be a tube formed from spirally wound paper. The hollow tubular element may be formed from a plurality of layers of the paper. The paper may have a basis weight of at least about 50 grams per square meter, at least about 60 grams per square meter, at least about 70 grams per square meter, or at least about 90 grams per square meter.

[0218] Where the tubular element comprises paper, the paper may have a thickness of at least about 50 micrometres. For example, the paper may have a thickness of at least about 70 micrometres, at least about 90 micrometres, or at least about 100 micrometres.

[0219] The hollow tubular element may comprise a polymer. For example, the hollow tubular element may comprise a polymeric film. The polymeric film may comprise a cellulosic film. The hollow tubular element may comprise low density polyethylene (LDPE) or polyhydroxyalkanoate (PHA) fibres.

[0220] Preferably, in embodiments wherein the downstream section comprises a hollow tubular element, an internal diameter of the annular portion is smaller than an internal diameter of the hollow tubular element. As such, direct fluid communication is established between the annular portion and the internal cavity defined by the hollow tubular element.

[0221] Thus, when the aerosol-generating article is not received within an aerosol-generating device or is received within an aerosol-generating device not devised for use with the aerosol-generating article, air drawn into the aerosol-generating rod from the upstream end will flow primarily through the annular portion and directly into the cavity of the hollow tubular element. As such, the RTD encountered by such flow of air along the aerosol-generating article will depend solely on any component of the downstream section other than the hollow tubular element, if one such compo-

nent is present at all. For example, the overall RTD encountered by such flow of air along the aerosol-generating article may depend solely on an RTD of the mouthpiece, which will be described in more detail below.

[0222] In some embodiments, an aerosol-generating article in accordance with the present invention comprises a ventilation zone at a location along the hollow tubular element. The ventilation zone may allow cooler air from outside the aerosol-generating article to enter the internal cavity of the hollow tubular element.

[0223] The aerosol-generating article may typically have a ventilation level of at least about 10 percent, preferably at least about 20 percent.

[0224] In preferred embodiments, the aerosol-generating article has a ventilation level of at least about 20 percent or 25 percent or 30 percent. More preferably, the aerosol-generating article has a ventilation level of at least about 35 percent.

[0225] The aerosol-generating article preferably has a ventilation level of less than about 80 percent. More preferably, the aerosol-generating article has a ventilation level of less than about 60 percent or less than about 50 percent.

[0226] The aerosol-generating article may typically have a ventilation level of between about 10 percent and about 80 percent.

[0227] In some embodiments, the aerosol-generating article has a ventilation level from about 20 percent to about 80 percent, preferably from about 20 percent to about 60 percent, more preferably from about 20 percent to about 50 percent. In other embodiments, the aerosol-generating article has a ventilation level from about 25 percent to about 80 percent, preferably from about 25 percent to about 60 percent, more preferably from about 25 percent to about 50 percent. In further embodiments, the aerosol-generating article has a ventilation level from about 30 percent to about 80 percent, preferably from about 30 percent to about 60 percent, more preferably from about 30 percent to about 50 percent.

[0228] In particularly preferred embodiments, the aerosol-generating article has a ventilation level from about 40 percent to about 50 percent. In some particularly preferred embodiments, the aerosol-generating article has a ventilation level of about 45 percent.

[0229] Without wishing to be bound by theory, the inventors have found that the temperature drop caused by the admission of cooler, external air into the hollow tubular segment may have an advantageous effect on the nucleation and growth of aerosol particles.

[0230] Formation of an aerosol from a gaseous mixture containing various chemical species depends on a delicate interplay between nucleation, evaporation, and condensation, as well as coalescence, all the while accounting for variations in vapour concentration, temperature, and velocity fields. The so-called classical nucleation theory is based on the assumption that a fraction of the molecules in the gas phase are large enough to stay coherent for long times with sufficient probability (for example, a probability of one half). These molecules represent some kind of a critical, threshold molecule clusters among transient molecular aggregates, meaning that, on average, smaller molecule clusters are likely to disintegrate rather quickly into the gas phase, while larger clusters are, on average, likely to grow. Such critical cluster is identified as the key nucleation core from which droplets are expected to grow due to conden-

sation of molecules from the vapour. It is assumed that virgin droplets that just nucleated emerge with a certain original diameter, and then may grow by several orders of magnitude. This is facilitated and may be enhanced by rapid cooling of the surrounding vapour, which induces condensation. In this connection, it helps to bear in mind that evaporation and condensation are two sides of one same mechanism, namely gas-liquid mass transfer. While evaporation relates to net mass transfer from the liquid droplets to the gas phase, condensation is net mass transfer from the gas phase to the droplet phase. Evaporation (or condensation) will make the droplets shrink (or grow), but it will not change the number of droplets.

[0231] In this scenario, which may be further complicated by coalescence phenomena, the temperature and rate of cooling can play a critical role in determining how the system responds. In general, different cooling rates may lead to significantly different temporal behaviours as concerns the formation of the liquid phase (droplets), because the nucleation process is typically nonlinear. Without wishing to be bound by theory, it is hypothesised that cooling can cause a rapid increase in the number concentration of droplets, which is followed by a strong, short-lived increase in this growth (nucleation burst). This nucleation burst would appear to be more significant at lower temperatures. Further, it would appear that higher cooling rates may favour an earlier onset of nucleation. By contrast, a reduction of the cooling rate would appear to have a favourable effect on the final size that the aerosol droplets ultimately reach.

[0232] Therefore, the rapid cooling induced by the admission of external air into the hollow tubular segment can be favourably used to favour nucleation and growth of aerosol droplets. However, at the same time, the admission of external air into the hollow tubular segment has the immediate drawback of diluting the aerosol stream delivered to the consumer.

[0233] The inventors have surprisingly found that the diluting effect on the aerosol-which can be assessed by measuring, in particular, the effect on the delivery of aerosol former (such as glycerol) included in the aerosol-generating substrate) is advantageously minimised when the ventilation level is within the ranges described above. In particular, ventilation levels between 25 percent and 50 percent, and even more preferably between 28 and 42 percent, have been found to lead to particularly satisfactory values of glycerin delivery. At the same time, the extent of nucleation and, as a consequence, the delivery of nicotine and aerosol-former (for example, glycerol) are enhanced.

[0234] A thickness of a peripheral wall (in other words, the wall thickness) of the hollow tubular element may be at least about 100 micrometres. The wall thickness of the hollow tubular element may be at least about 150 micrometres. The wall thickness of the hollow tubular element may be at least about 200 micrometres, preferably at least about 250 micrometres and even more preferably at least about 500 micrometres (or 0.5 mm).

[0235] The wall thickness of the hollow tubular element may be less than or equal to 2 millimetres, preferably less than or equal to 1.5 millimetres and even more preferably less than or equal to 1.25 mm. The wall thickness of the hollow tubular element may be less than or equal to 1 millimetre. The wall thickness of the hollow tubular element may be less than or equal to 500 micrometres.

[0236] The wall thickness of the hollow tubular element may be between 100 micrometres and 2 millimetres, preferably between 150 micrometres and 1.5 millimetres, even more preferably between 200 micrometres and 1.25 millimetres.

[0237] The wall thickness of the hollow tubular element may preferably be about 250 micrometres (0.25 mm).

[0238] Keeping the thickness of the peripheral wall of the hollow tubular element relatively low ensures that the overall internal volume of the hollow tubular element—which is made available for the aerosol to begin the nucleation process as soon as the aerosol components leave the rod of aerosol-generating substrate—and the cross-sectional surface area of the hollow tubular element are effectively maximised, whilst at the same time ensuring that the hollow tubular element has the necessary structural strength to prevent a collapse of the aerosol-generating article as well as to provide some support to the aerosol-generating rod, and that the RTD of the hollow tubular element is minimised. Greater values of cross-sectional surface area of the cavity of the hollow tubular element are understood to be associated with a reduced speed of the aerosol stream travelling along the aerosol-generating article, which is also expected to favour aerosol nucleation. Further, it would appear that by utilising a hollow tubular element having a relatively low thickness, it is possible to substantially prevent diffusion of the ventilation air prior to its contacting and mixing with the stream of aerosol, which is also understood to further favour nucleation phenomena. In practice, by providing a more controllably localised cooling of the stream of volatilised species, it is possible to enhance the effect of cooling on the formation of new aerosol particles.

[0239] The ventilation zone may comprise a first line of perforation holes circumscribing the hollow tubular element. In some embodiments, the ventilation zone may comprise two circumferential rows of perforation holes. For example, the perforation holes may be formed online during manufacturing of the aerosol-generating article. Each circumferential row of perforation holes may comprise between about 5 and about 40 perforations, for example each circumferential row of perforation holes may comprise between about 8 and about 30 perforations.

[0240] Where the aerosol-generating article comprises a combining plug wrap the ventilation zone preferably comprises at least one corresponding circumferential row of perforation holes provided through a portion of the combining plug wrap. These may also be formed online during manufacture of the smoking article. Preferably, the circumferential row or rows of perforation holes provided through a portion of the combining plug wrap are in substantial alignment with the row or rows of perforations through the downstream section.

[0241] Where the aerosol-generating article comprises a band of tipping paper, wherein the band of tipping paper extends over the circumferential row or rows of perforations in the downstream section, the ventilation zone preferably comprises at least one corresponding circumferential row of perforation holes provided through the band of tipping paper. These may also be formed online during manufacture of the smoking article. Preferably, the circumferential row or rows of perforation holes provided through the band of tipping paper are in substantial alignment with the row or rows of perforations through the downstream section.

[0242] The ventilation zone may be located anywhere along the length of the hollow tubular element.

[0243] In some embodiments, the ventilation zone may be located at least 8 millimetres from a downstream end of the aerosol-generating article. For example, the ventilation zone may be located at least 10 millimetres, at least 12 millimetres, or at least 15 millimetres from the downstream end of the aerosol-generating article. Locating the first ventilation zone as outlined above may advantageously prevent the first ventilation zone being occluded by a consumer's mouth or lips when the aerosol-generating article is in use.

[0244] The ventilation zone may be located no more than 25 millimetres from the downstream end of the aerosol-generating article. For example, the ventilation zone may be located 20 millimetres from the downstream end of the aerosol-generating article. Locating the ventilation zone as outlined above may advantageously prevent the ventilation zone being occluded when the aerosol-generating article is inserted into an aerosol-generating device.

[0245] The ventilation zone may be located at least 2 millimetres from an upstream end of the hollow tubular element. For example, the ventilation zone may be located at least 3 millimetres from an upstream end of the hollow tubular element or at least 4 millimetres from an upstream end of the hollow tubular element or at least 5 millimetres from an upstream end of the hollow tubular element.

[0246] In some embodiments, the ventilation zone may be located less than 20 millimetres from a downstream end of the hollow tubular element, preferably less than 18 millimetres from a downstream end of the hollow tubular element, more preferably less than 16 millimetres from a downstream end of the hollow tubular element, even more preferably less than 14 millimetres from a downstream end of the hollow tubular element.

[0247] In the context of the present invention, a hollow tubular element provides an unrestricted flow channel. This means that the hollow tubular element provides a negligible level of resistance to draw (RTD). The term “negligible level of RTD” is used to describe an RTD of less than 1 mm H₂O per 10 millimetres of length of the hollow tubular element or hollow tubular element, preferably less than 0.4 mm H₂O per 10 millimetres of length of the hollow tubular element or hollow tubular element, more preferably less than 0.1 mm H₂O per 10 millimetres of length of the hollow tubular element or hollow tubular element.

[0248] Unless otherwise specified, the resistance to draw (RTD) of a component or the aerosol-generating article is measured in accordance with ISO 6565-2015. The RTD refers to the pressure required to force air through the full length of a component. The terms “pressure drop” or “draw resistance” of a component or article may also refer to the “resistance to draw”. Such terms generally refer to the measurements in accordance with ISO 6565-2015 are normally carried out at under test at a volumetric flow rate of about 17.5 millilitres per second at the output or downstream end of the measured component at a temperature of about 22 degrees Celsius, a pressure of about 101 kPa (about 760 Torr) and a relative humidity of about 60 percent.

[0249] The RTD of a hollow tubular element is preferably less than or equal to about 10 millimetres H₂O. More preferably, the RTD of a hollow tubular element is less than or equal to about 5 millimetres H₂O. Even more preferably, the RTD of a hollow tubular element is less than or equal to about 2.5 millimetres H₂O. Even more preferably, the RTD of the hollow tubular element is less than or equal to about 2 millimetres H₂O. Even more preferably, the RTD of the

hollow tubular element is less than or equal to about 1 millimetre H_2O . The RTD of a hollow tubular element may be at least 0 millimetres H_2O , or at least about 0.25 millimetres H_2O or at least about 0.5 millimetres H_2O or at least about 1 millimetre H_2O .

[0250] In some embodiments, the RTD of a hollow tubular element is from about 0 millimetre H_2O to about 10 millimetres H_2O , preferably from about 0.25 millimetres H_2O to about 10 millimetres H_2O , preferably from about 0.5 millimetres H_2O to about 10 millimetres H_2O . In other embodiments, the RTD of a hollow tubular element is from about 0 millimetres H_2O to about 5 millimetres H_2O , preferably from about 0.25 millimetres H_2O to about 5 millimetres H_2O preferably from about 0.5 millimetres H_2O to about 5 millimetres H_2O . In other embodiments, the RTD of a hollow tubular element is from about 1 millimetre H_2O to about 5 millimetres H_2O . In further embodiments, the RTD of a hollow tubular element is from about 0 millimetres H_2O to about 2.5 millimetres H_2O , preferably from about 0.25 millimetres H_2O to about 2.5 millimetres H_2O , more preferably from about 0.5 millimetres H_2O to about 2.5 millimetres H_2O . In further embodiments, the RTD of a hollow tubular element is from about 0 millimetres H_2O to about 2 millimetres H_2O , preferably from about 0.25 millimetres H_2O to about 2 millimetres H_2O , more preferably from about 0.5 millimetres H_2O to about 2 millimetres H_2O . In a particularly preferred embodiment, the RTD of a hollow tubular element is about 0 millimetre H_2O .

[0251] In aerosol-generating articles in accordance with the present invention the overall RTD of the article depends essentially on the RTD of the aerosol-generating rod and may optionally also depend on the RTD of other components of the downstream section, such as for example a mouthpiece, as will be described below. This is because the hollow tubular segment is substantially empty and, as such, substantially only marginally contribute to the overall RTD of the aerosol-generating article. The internal cavity of the hollow tubular element should therefore be free from any components that would obstruct the flow of air in a longitudinal direction. Preferably, the internal cavity is substantially empty.

[0252] In effect, since the annular portion does not substantially contribute to the overall RTD of the article, the overall RTD of the article is primarily dependent on the core portion and optionally on components of the downstream section other than the hollow tubular element.

[0253] In aerosol-generating articles in accordance with the present invention, the downstream section may comprise a mouthpiece element. In some embodiments, the downstream section comprises a mouthpiece element downstream of the hollow tubular element, and the article further comprises a wrapper circumscribing the aerosol-generating rod, the hollow tubular element and the mouthpiece.

[0254] The mouthpiece element may be located immediately downstream of the hollow tubular element. Thus, the mouthpiece element may extend from a downstream end of the hollow tubular element to a mouth end of the aerosol-generating article or to the downstream end of the downstream section.

[0255] In such embodiments, as the hollow tubular element abuts an upstream end of the mouthpiece element, the internal cavity of the hollow tubular element is in direct fluid communication with the mouthpiece element.

[0256] In aerosol-generating articles in accordance with the present invention, a length of the mouthpiece element may be at least 5 millimetres. Preferably, a length of the mouthpiece element is at least 10 millimetres. More preferably, a length of the mouthpiece element is at least 12 millimetres. Even more preferably, a length of the mouthpiece element is at least 15 millimetres.

[0257] Preferably, a length of the mouthpiece element is less than or equal to 45 millimetres. More preferably, a length of the mouthpiece element is less than or equal to 40 millimetres. Even more preferably, a length of the mouthpiece element is less than or equal to 40 millimetres.

[0258] In preferred embodiments, a length of the mouthpiece element is less than or equal to 35 millimetres. More preferably, a length of the mouthpiece element is less than or equal to 30 millimetres. Even more preferably, a length of the mouthpiece element is less than or equal to 25 millimetres. In particularly preferred embodiments, a length of the mouthpiece element is less than or equal to 22 millimetres.

[0259] In some embodiments, a length of the mouthpiece element is from 10 millimetres to 45 millimetres, preferably from 10 millimetres to 40 millimetres, more preferably from 10 millimetres to 35 millimetres, even more preferably from 10 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the mouthpiece element is from 10 millimetres to 25 millimetres, preferably from 10 millimetres to 22 millimetres.

[0260] In other embodiments, a length of the mouthpiece element is from 12 millimetres to 45 millimetres, preferably from 12 millimetres to 40 millimetres, more preferably from 12 millimetres to 35 millimetres, even more preferably from 12 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the mouthpiece element is from 12 millimetres to 25 millimetres, preferably from 12 millimetres to 22 millimetres.

[0261] In further embodiments, a length of the mouthpiece element is from 15 millimetres to 45 millimetres, preferably from 15 millimetres to 40 millimetres, more preferably from 15 millimetres to 35 millimetres, even more preferably from 15 millimetres to 30 millimetres. In particularly preferred embodiments, a length of the mouthpiece element is from 15 millimetres to 25 millimetres, preferably from 15 millimetres to 22 millimetres.

[0262] An outer diameter of the mouthpiece element preferably substantially matches an outer diameter of the annular portion or an outer diameter of the hollow tubular element or both.

[0263] The mouthpiece element may be formed of a fibrous material.

[0264] The mouthpiece element may be formed of a porous material. The mouthpiece element may be formed of a biodegradable material. The mouthpiece element may be formed of a cellulose material, such as cellulose acetate. The mouthpiece element may be formed of a polylactic acid based material. The mouthpiece element may be formed of a bioplastic material, preferably a starch-based bioplastic material. The mouthpiece element may be made by injection moulding or by extrusion. Bioplastic-based materials are advantageous because they are able to provide mouthpiece element structures that are simple and cheap to manufacture with a particular and complex cross-sectional profile, which may comprise a plurality of relatively large air flow channels extending through the mouthpiece element material, that provides suitable RTD characteristics.

[0265] The mouthpiece element may be formed from a sheet of suitable material that has been crimped, pleated, gathered, woven or folded into an element that defines a plurality of longitudinally extending channels. Such sheet of suitable material may be formed of paper, cardboard, a polymer, such as polylactic acid, or any other cellulose-based, paper-based material or bioplastic-based material. A cross-sectional profile of such a mouthpiece element may show the channels as being randomly oriented.

[0266] The mouthpiece element may be formed in any other suitable manner. For example, the mouthpiece element may be formed from a bundle of longitudinally extending tubes. The longitudinally extending tubes may be formed from polylactic acid. The mouthpiece element may be formed by extrusion, moulding, lamination, injection, or shredding of a suitable material. Thus, it is preferred that there is a low-pressure drop (or RTD), yet non-zero, from an upstream end of the mouthpiece element to a downstream end of the mouthpiece element.

[0267] The mouthpiece element may comprise at least one filter (air flow) channel extending along the mouthpiece element. Preferably, the at least one filter air flow channel extend along the whole length of the mouthpiece element. The at least one filter channel may have a substantially circular cross-section. The at least one filter channel may have a substantially Y-shaped or T-shaped cross-section. The mouthpiece element may comprises a plurality of such filter air flow channels extending along the mouthpiece element. The mouthpiece element may comprise at least three filter air flow channels. The provision of at least one filter air flow channel in the mouthpiece element allows the mouthpiece element to meet particular RTD values.

[0268] The resistance to draw (RTD) of the mouthpiece element may be at least about 0 mm H₂O. The RTD of the mouthpiece element may be at least about 3 mm H₂O. The RTD of the mouthpiece element may be at least about 6 mm H₂O.

[0269] The RTD of the mouthpiece element may be no greater than about 12 mm H₂O. The RTD of the mouthpiece element may be no greater than about 11 mm H₂O. The RTD of the mouthpiece element may be no greater than about 10 mm H₂O.

[0270] The resistance to draw of the mouthpiece element may be greater than or equal to about 0 mm H₂O and less than about 12 mm H₂O. Preferably, the resistance to draw of the mouthpiece element may be greater than or equal to about 3 mm H₂O and less than about 12 mm H₂O. The resistance to draw of the mouthpiece element may be greater than or equal to about 0 mm H₂O and less than about 11 mm H₂O. Even more preferably, the resistance to draw of the mouthpiece element may be greater than or equal to about 3 mm H₂O and less than about 11 mm H₂O. Even more preferably, the resistance to draw of the mouthpiece element may be greater than or equal to about 6 mm H₂O and less than about 10 mm H₂O. Preferably, the resistance to draw of the mouthpiece element may be about 8 mm H₂O.

[0271] The aerosol-generating article may have an overall length from about 30 millimetres to about 110 millimetres.

[0272] Preferably, an overall length of an aerosol-generating article in accordance with the invention is at least about 30 millimetres. More preferably, an overall length of an aerosol-generating article in accordance with the invention is at least about 40 millimetres. Even more preferably, an

overall length of an aerosol-generating article in accordance with the invention is at least about 42 millimetres.

[0273] An overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 90 millimetres. More preferably, an overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 80 millimetres. Even more preferably, an overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 70 millimetres.

[0274] In some embodiments, an overall length of the aerosol-generating article is preferably from 30 millimetres to 90 millimetres, more preferably from 40 millimetres to 90 millimetres, even more preferably from 42 millimetres to 90 millimetres. In other embodiments, an overall length of the aerosol-generating article is preferably from 30 millimetres to 80 millimetres, more preferably from 40 millimetres to 80 millimetres, even more preferably from 42 millimetres to 80 millimetres. In further embodiments, an overall length of the aerosol-generating article is preferably from 30 millimetres to 70 millimetres, more preferably from 40 millimetres to 70 millimetres, even more preferably from 42 millimetres to 70 millimetres.

[0275] An outer diameter of the aerosol-generating article may be at least 4 millimetres. Preferably, an outer diameter of the aerosol-generating article is at least 5 millimetres. More preferably, outer diameter of the aerosol-generating article is at least 6 millimetres. An outer diameter of the aerosol-generating article is preferably less than or equal to 12 millimetres, more preferably less than or equal to 10 millimetres, even more preferably less than or equal to 8 millimetres.

[0276] In some embodiments, an outer diameter of the aerosol-generating article is from 4 millimetres to 12 millimetres, preferably from 4 millimetres to 10 millimetres, more preferably from 4 millimetres to 8 millimetres. In other embodiments, an outer diameter of the aerosol-generating article is from 5 millimetres to 12 millimetres, preferably from 5 millimetres to 10 millimetres, more preferably from 5 millimetres to 8 millimetres. In further embodiments, an outer diameter of the aerosol-generating article is from 6 millimetres to 12 millimetres, preferably from 6 millimetres to 10 millimetres, more preferably from 6 millimetres to 8 millimetres.

[0277] The outer diameter of the aerosol-generating article may be substantially constant over the whole length of the aerosol-generating article. As an alternative, different portions of the aerosol-generating article may have different outer diameters.

[0278] In particularly preferred embodiments, one or more of the components of the aerosol-generating article are individually circumscribed by their own wrapper.

[0279] In an embodiment, the aerosol-generating rod and the mouthpiece element are individually wrapped. The aerosol-generating rod and the hollow tubular element are then combined together with an outer wrapper. Subsequently, the combined aerosol-generating rod and hollow tubular element are further combined with the mouthpiece element—which has its own wrapper—by means of tipping paper.

[0280] Preferably, at least one of the components of the aerosol-generating article is wrapped in a hydrophobic wrapper.

[0281] The term “hydrophobic” refers to a surface exhibiting water repelling properties. One useful way to deter-

mine this is to measure the water contact angle. The “water contact angle” is the angle, conventionally measured through the liquid, where a liquid/vapour interface meets a solid surface. It quantifies the wettability of a solid surface by a liquid via the Young equation. Hydrophobicity or water contact angle may be determined by utilizing TAPPI T558 test method and the result is presented as an interfacial contact angle and reported in “degrees” and can range from near zero to near 180 degrees.

[0282] In preferred embodiments, the hydrophobic wrapper is one including a paper layer having a water contact angle of about 30 degrees or greater, and preferably about 35 degrees or greater, or about 40 degrees or greater, or about 45 degrees or greater.

[0283] By way of example, the paper layer may comprise PVOH (polyvinyl alcohol) or silicon. The PVOH may be applied to the paper layer as a surface coating, or the paper layer may comprise a surface treatment comprising PVOH or silicon.

[0284] In a particularly preferred embodiment, an aerosol-generating article in accordance with the present invention comprises, in linear sequential arrangement, an aerosol-generating rod, a hollow tubular element located immediately downstream of the aerosol-generating rod, a mouthpiece element located immediately downstream of the hollow tubular element, and one or more outer wrappers combining the aerosol-generating rod, the hollow tubular element and the mouthpiece element. The hollow tubular element and the mouthpiece element form the downstream section of the aerosol-generating article.

[0285] The hollow tubular element may abut the aerosol-generating rod. The mouthpiece element may abut the hollow tubular element. Preferably, the hollow tubular element abuts the aerosol-generating rod and the mouthpiece element abuts the hollow tubular element.

[0286] In such particularly preferred embodiment the aerosol-generating article has a substantially cylindrical shape and an outer diameter of from 4.9 millimetres to 9 millimetres. In an especially preferred embodiment, the aerosol-generating article has a substantially cylindrical shape and an outer diameter of 7.7 millimetres. An overall length of the aerosol-generating article is from 30 millimetres to 75 millimetres, in an especially preferred embodiment 45 millimetres.

[0287] The aerosol-generating rod has a length of from 5 millimetres to 25 millimetres. In an especially preferred embodiment, the aerosol-generating rod has a length of about 11 millimetres. The hollow tubular element has a length of from 5 millimetres to 35 millimetres. In an especially preferred embodiment, the hollow tubular element has a length of about 11 millimetres. The mouthpiece element has a length of from 5 millimetres to 15 millimetres. In an especially preferred embodiment, the mouthpiece has a length of about 22 millimetres.

[0288] An overall length of the article is from 15 millimetres to 75 millimetres. In an especially preferred embodiment, the aerosol-generating article has a length of about 45 millimetres.

[0289] The aerosol-generating rod comprises a core portion that contains at least one of the types of aerosol-generating substrate described above, and preferably a shredded tobacco material or a gathered homogenised tobacco material. In a preferred embodiment, the core por-

tion comprises a shredded tobacco material comprising from 13 percent by weight to 18 percent by weight of glycerol.

[0290] The aerosol-generating rod comprises an annular portion that radially abuts the core portion and has an outer diameter substantially matching an outer diameter of the aerosol-generating article and. In an especially preferred embodiment, a thickness of the annular portion is 1.8 millimetres. An internal diameter of the annular portion substantially matches an outer diameter of the core portion. The annular portion is formed of a plurality of linear, axially extending fibres of at least one of the types described above.

[0291] The hollow tubular element is in the form of a cardboard tube or a cellulose acetate tube and has an internal diameter of from 3.4 millimetres to 9.5 millimetres. A thickness of a peripheral wall of the hollow tube segment is about 0.5 millimetres to 1.8 millimetres.

[0292] A ventilation zone comprising a circumferential row of openings is provided along the hollow tubular element at 5 to 30 millimetres from an upstream end of the hollow tubular element.

[0293] The mouthpiece element is in the form of a low-density cellulose acetate filter segment. As discussed above, the present disclosure also relates to an aerosol-generating system comprising an aerosol-generating device having a distal end and a mouth end. The aerosol-generating device may comprise a body. The body or housing of the aerosol-generating device may define a device cavity for removably receiving the aerosol-generating article at the mouth end of the device. The aerosol-generating device may comprise a heating element or heater for heating the aerosol-generating substrate when the aerosol-generating article is received within the device cavity.

[0294] The device cavity may be referred to as the heating chamber of the aerosol-generating device. The device cavity may extend between a distal end and a mouth, or proximal, end. The distal end of the device cavity may be a closed end and the mouth, or proximal, end of the device cavity may be an open end. An aerosol-generating article may be inserted into the device cavity, or heating chamber, via the open end of the device cavity. The device cavity may be cylindrical in shape so as to conform to the same shape of an aerosol-generating article.

[0295] The expression “received within” may refer to the fact that a component or element is fully or partially received within another component or element. For example, the expression “aerosol-generating article is received within the device cavity” refers to the aerosol-generating article being fully or partially received within the device cavity of the aerosol-generating article. When the aerosol-generating article is received within the device cavity, the aerosol-generating article may abut the distal end of the device cavity. When the aerosol-generating article is received within the device cavity, the aerosol-generating article may be in substantial proximity to the distal end of the device cavity. The distal end of the device cavity may be defined by an end-wall.

[0296] The length of the device cavity may be between about 10 mm and about 50 mm. The length of the device cavity may be between about 20 mm and about 40 mm. The length of the device cavity may be between about 25 mm and about 30 mm.

[0297] The length of the device cavity (or heating chamber) may be the same as or greater than the length of the aerosol-generating rod. The length of the device cavity may

be such that the downstream section or a portion thereof is configured to protrude from the device cavity, when the aerosol-generating article is received within the device cavity. The length of the device cavity may be such that a portion of the downstream section (such as the hollow tubular element or mouthpiece element) is configured to protrude from the device cavity, when the aerosol-generating article is received within the device cavity. The length of the device cavity may be such that a portion of the downstream section (such as the hollow tubular element or mouthpiece element) is configured to be received within the device cavity, when the aerosol-generating article is received within the device cavity.

[0298] A diameter of the device cavity may be between about 4 mm and about 10 mm. A diameter of the device cavity may be between about 5 mm and about 9 mm. A diameter of the device cavity may be between about 6 mm and about 8 mm. A diameter of the device cavity may be between about 7 mm and about 8 mm. A diameter of the device cavity may be between about 7 mm and about 7.5 mm.

[0299] A diameter of the device cavity may be substantially the same as or greater than a diameter of the aerosol-generating article. A diameter of the device cavity may be the same as a diameter of the aerosol-generating article in order to establish a tight fit with the aerosol-generating article.

[0300] The device cavity may be configured to establish a tight fit with an aerosol-generating article received within the device cavity. Tight fit may refer to a snug fit. The aerosol-generating device may comprise a peripheral wall. Such a peripheral wall may define the device cavity, or heating chamber. The peripheral wall defining the device cavity may be configured to engage with an aerosol-generating article received within the device cavity in a tight fit manner, so that there is substantially no gap or empty space between the peripheral wall defining the device cavity and the aerosol-generating article when received within the device.

[0301] Such a tight fit may establish an airtight fit or configuration between the device cavity and an aerosol-generating article received therein.

[0302] With such an airtight configuration, there would be substantially no gap or empty space between the peripheral wall defining the device cavity and the aerosol-generating article for air to flow through.

[0303] The tight fit with an aerosol-generating article may be established along the entire length of the device cavity or along a portion of the length of the device cavity.

[0304] The aerosol-generating device comprises an airflow channel extending between a channel inlet and a channel outlet. The airflow channel may be configured to establish a fluid communication between the interior of the device cavity and the exterior of the aerosol-generating device. The airflow channel of the aerosol-generating device may be defined within the housing of the aerosol-generating device to enable fluid communication between the interior of the device cavity and the exterior of the aerosol-generating device. When an aerosol-generating article is received within the device cavity, the airflow channel may be configured to provide air flow into the article in order to deliver generated aerosol to a user drawing from the mouth end of the article.

[0305] In more detail, in a system in accordance with the present invention the aerosol-generating device comprises a heating chamber at a proximal end to at least partly receive the aerosol-generating rod to heat the aerosol-generating substrate, and the aerosol-generating device comprising an opening at a distal end to admit airflow into the heating chamber along a longitudinal axis of the heating chamber. A diameter of such opening, which defines an airflow channel as described above, is smaller than the internal diameter of the annular portion.

[0306] This has the benefit that, when the aerosol-generating article is inserted all the way into the heating chamber, a direct fluid communication is established between the exterior of the aerosol-generating device and the core portion of the aerosol-generating rod. At the same time, the distal end wall in which the opening is formed effectively occludes an upstream end of the annular portion, such that fluid communication between the exterior of the aerosol-generating device and the annular portion is substantially disabled, and airflow from the exterior of the aerosol-generating device into the annular portion is substantially prevented.

[0307] As such, during use, the imbalance in porosity and RTD between the core portion and the annular portion is offset, and an overall RTD of the aerosol-generating article will substantially correspond to a sum of the RTD of the core portion and an RTD of the downstream section.

[0308] During use, with the annular portion occluded, an RTD of the aerosol-generating system may be at least 60 millimetres H₂O, preferably at least 70 millimetres H₂O, more preferably at least 80 millimetres H₂O.

[0309] During use, with the annular portion occluded, an RTD of the aerosol-generating system may be less than or equal to 160 millimetres H₂O, preferably less than or equal to 150 millimetres H₂O, more preferably less than or equal to 140 millimetres H₂O.

[0310] In some embodiments, in the aerosol-generating device the heater is an internal heater, such as a pin heater or blade heater that is configured for insertion into the core portion when the aerosol-generating article is received within the heating chamber. The heater may be positioned within the device cavity, or heating chamber.

[0311] The heater may comprise one or more resistive heating elements. Suitable materials for forming the one or more resistive heating elements include but are not limited to: semiconductors such as doped ceramics, electrically 'conductive' ceramics (such as, for example, molybdenum disilicide), carbon, graphite, metals, metal alloys and composite materials made of a ceramic material and a metallic material. Such composite materials may comprise doped or undoped ceramics. Examples of suitable doped ceramics include doped silicon carbides. Examples of suitable metals include titanium, zirconium, tantalum and metals from the platinum group. Examples of suitable metal alloys include stainless steel, nickel-, cobalt-, chromium-, aluminium-titanium-zirconium-, hafnium-, niobium-, molybdenum-, tantalum-, tungsten-, tin-, gallium-, manganese- and iron-containing alloys, and super-alloys based on nickel, iron, cobalt, stainless steel, Timetal® and iron-manganese-aluminium based alloys.

[0312] In some embodiments, the one or more resistive heating elements comprise one or more stamped portions of electrically resistive material, such as stainless steel. Alternatively, the at least one resistive heating element may

comprise a heating wire or filament, for example a Ni—Cr (Nickel-Chromium), platinum, tungsten or alloy wire.

[0313] In some embodiments, the heater comprises an electrically insulating substrate, wherein the one or more resistive heating element are provided on the electrically insulating substrate.

[0314] The electrically insulating substrate may comprise any suitable material. For example, the electrically insulating substrate may comprise one or more of: paper, glass, ceramic, anodized metal, coated metal, and Polyimide. The ceramic may comprise mica, Alumina (Al_2O_3) or Zirconia (ZrO_2). Preferably, the electrically insulating substrate has a thermal conductivity of less than or equal to about 40 Watts per metre Kelvin, preferably less than or equal to about 20 Watts per metre Kelvin and ideally less than or equal to about 2 Watts per metre Kelvin.

[0315] The heater may comprise a heating element comprising a rigid electrically insulating substrate with one or more electrically conductive tracks or wire disposed on its surface. The size and shape of the electrically insulating substrate may allow it to be inserted directly into an aerosol-generating substrate. If the electrically insulating substrate is not sufficiently rigid, the heating element may comprise a further reinforcement means. A current may be passed through the one or more electrically conductive tracks to heat the heating element and the aerosol-generating substrate.

[0316] In other embodiments, as described above, the aerosol-generating article comprises a susceptor element embedded within the core portion and adapted to heat the aerosol-generating substrate. In those embodiments, the heater in the aerosol-generating device may comprise an inductive heating arrangement. The inductive heating arrangement may comprise an inductor coil and a power supply configured to provide high frequency oscillating current to the inductor coil. As used herein, a high frequency oscillating current means an oscillating current having a frequency of between about 500 kHz and about 30 MHz. The heater may advantageously comprise a DC/AC inverter for converting a DC current supplied by a DC power supply to the alternating current. The inductor coil may be arranged to generate a high frequency oscillating electromagnetic field on receiving a high frequency oscillating current from the power supply. The inductor coil may be arranged to generate a high frequency oscillating electromagnetic field in the device cavity. In some embodiments, the inductor coil may substantially circumscribe the device cavity. The inductor coil may extend at least partially along the length of the device cavity.

[0317] During use, the heater may be controlled to operate within a defined operating temperature range, below a maximum operating temperature. An operating temperature range between about 150 degrees Celsius and about 300 degrees Celsius in the heating chamber (or device cavity) is preferable. The operating temperature range of the heater may be between about 150 degrees Celsius and about 250 degrees Celsius.

[0318] Preferably, the operating temperature range of the heater may be between about 150 degrees Celsius and about 200 degrees Celsius. More preferably, the operating temperature range of the heater may be between about 180 degrees Celsius and about 200 degrees Celsius.

[0319] The aerosol-generating device may comprise a power supply. The power supply may be a DC power supply.

In some embodiments, the power supply is a battery. The power supply may be a nickel-metal hydride battery, a nickel cadmium battery, or a lithium based battery, for example a lithium-cobalt, a lithium-iron-phosphate or a lithium-polymer battery. However, in some embodiments the power supply may be another form of charge storage device, such as a capacitor. The power supply may require recharging and may have a capacity that allows for the storage of enough energy for one or more user operations, for example one or more aerosol-generating experiences. For example, the power supply may have sufficient capacity to allow for continuous heating of an aerosol-generating substrate for a period of around six minutes, corresponding to the typical time taken to smoke a conventional cigarette, or for a period that is a multiple of six minutes. In another example, the power supply may have sufficient capacity to allow for a predetermined number of puffs or discrete activations of the heater.

[0320] 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.

[0321] EX1. An aerosol-generating article comprising an aerosol-generating rod extending from an upstream end to a downstream end; and a downstream section provided downstream of the aerosol-generating rod and abutting the downstream end of the aerosol-generating rod; wherein the aerosol-generating rod comprises a substantially cylindrical core portion having a longitudinal axis and an annular portion surrounding and extending coaxially with the core portion; wherein the annular portion is air permeable, such that an upstream end of the annular portion internal is in fluid communication with the downstream section.

[0322] EX2. An aerosol-generating article according to example EX1, wherein the core portion comprises an aerosol-generating substrate and has an average porosity of from 0.15 to 0.45.

[0323] EX3. An aerosol-generating article according to example EX1 or EX3, an average porosity of the annular portion being at least 120 percent of the average porosity of the core portion.

[0324] EX4. An aerosol-generating article according to any preceding example, wherein the downstream section comprises a hollow tubular element, the hollow tubular element defining an internal cavity and abutting the downstream end of the aerosol-generating rod.

[0325] EX5. An aerosol-generating article according to EX4, wherein an internal diameter of the annular portion is smaller than an internal diameter of the hollow tubular element.

[0326] EX6. An aerosol-generating article according to EX4 or EX5, wherein the downstream section comprises a mouthpiece element downstream of the hollow tubular element, the article further comprising a wrapper circumscribing the aerosol-generating rod, the hollow tubular element and the mouthpiece.

[0327] EX7. An aerosol-generating article according to any one EX4 to EX6, comprising a ventilation zone at a location along the hollow tubular element.

[0328] EX8. An aerosol-generating article according to any one of the preceding examples, wherein the annular portion comprises linear, axially oriented fibres.

[0329] EX9. An aerosol-generating article according to EX8, wherein the fibres are selected from: cellulose acetate fibres, poly lactic acid (PLA) fibres, polypropylene fibres, poly(3-hydroxybutyrate-co-hydroxyvalerate) (PHVB) fibres, rayon fibres, viscose fibres, regenerated cellulose fibres, and combinations thereof.

[0330] EX10. An aerosol-generating article according to EX8 or EX9, wherein the annular portion comprises two or more longitudinal segments of tow material, and the tow material of adjacent ones of the two or more longitudinal segments is bonded together at least along longitudinal edges of the segments to form an integral annular portion.

[0331] EX11. An aerosol-generating article according to any one of examples 8 to 10, wherein the fibres have a denier per filament (dpf) from 3.0 dpf to 15.0 dpf.

[0332] EX12. An aerosol-generating article according to claim 11, wherein the fibres have a dpf from 5.0 dpf to 10.0 dpf.

[0333] EX13. An aerosol-generating article according to any one of examples 8 to 12, wherein the fibres have a Y-shaped cross-section.

[0334] EX14. An aerosol-generating article according to any one of the preceding examples, wherein the core portion has a cross-sectional porosity of from 0.15 to 0.30.

[0335] EX15. An aerosol-generating article according to any one of the preceding examples, wherein the core portion has a cross-sectional porosity distribution of from 0.04 to 0.22.

[0336] EX16. An aerosol-generating article according to any one of the preceding examples, wherein the annular portion has a cross-sectional porosity of from 0.3 to 0.95.

[0337] EX17. An aerosol-generating article according to any one of the preceding examples, comprising a susceptor element arranged within the core portion and thermally coupled with the aerosol-generating substrate.

[0338] EX18. An aerosol-generating article according to any one of the preceding examples, wherein a length of the aerosol-generating rod is from 10 millimetres to 35 millimetres.

[0339] EX19. An aerosol-generating article according to any one of the preceding examples, wherein a length of the hollow tubular element is from 10 millimetres to 35 millimetres.

[0340] EX20. An aerosol-generating article according to any one of the preceding examples, wherein an outer diameter of the article is from 4 millimetres to 10 millimetres.

[0341] EX21. An aerosol-generating article according to any one of the preceding examples, wherein the annular portion radially abuts the core portion.

[0342] EX22. An aerosol-generating article according to any one of the preceding examples, wherein an outer diameter of the core portion is from 3 millimetres to 7 millimetres.

[0343] EX23. An aerosol-generating article according to any one of the preceding examples, wherein an outer diameter of the core portion is from 3.5 millimetres to 5.75 millimetres.

[0344] EX24. An aerosol-generating article according to any one of the preceding examples, wherein an overall length of the article is from 25 millimetres to 108 millimetres.

[0345] EX25. An aerosol-generating article according to any one of the preceding examples, wherein an overall length of the article is from 40 millimetres to 70 millimetres.

[0346] EX26. An aerosol-generating article according to any one of the preceding examples, wherein an RTD of the annular portion is from 10 millimetres H₂O to 65 millimetres H₂O.

[0347] EX27. An aerosol-generating article according to any one of the preceding examples, wherein an RTD of the annular portion is from 30 millimetres H₂O to 60 millimetres H₂O.

[0348] EX28. An aerosol-generating system comprising an aerosol-generating article according to any one of examples 1 to 27 and an aerosol-generating device comprising a heating chamber open at a proximal end to at least partly receive the aerosol-generating rod to heat the aerosol-generating substrate, the aerosol-generating device comprising an opening at a distal end to admit airflow into the heating chamber along a longitudinal axis of the heating chamber, wherein a diameter of the opening is smaller than the internal diameter of the annular portion.

[0349] EX29. An aerosol-generating system according to EX28, wherein, when the aerosol-generating article is received into the heating chamber and an upstream end of the aerosol-generating article abuts a distal end of the heating chamber, an RTD of the system is from 60 millimetres H₂O to 160 millimetres H₂O.

[0350] In the following, the invention will be further described with reference to the drawings of the accompanying Figures, wherein:

[0351] FIG. 1 shows a schematic side sectional view of an aerosol-generating article in accordance with an embodiment of the present invention;

[0352] FIG. 2 shows a schematic cross-sectional view of the aerosol-generating article of FIG. 1 taken along the line IV-IV; and

[0353] FIG. 3 shows a schematic side sectional view of an aerosol-generating system in accordance with an embodiment of the invention comprising the aerosol-generating article of FIGS. 1 and 2 and an aerosol-generating device.

[0354] The aerosol-generating article 10 shown in FIG. 1 comprises an aerosol-generating rod 12 and a downstream section 14 at a location downstream of the aerosol-generating rod 12. Thus, the aerosol-generating article 10 extends from an upstream or distal end 16—which substantially coincides with an upstream end of the aerosol-generating rod 12—to a downstream or mouth end 18, which coincides with a downstream end of the downstream section 14. The downstream section 14 comprises a hollow tubular element 30 and a mouthpiece element 50. A wrapper 24 circumscribes the aerosol-generating rod 12, the hollow tubular element 30 and the mouthpiece element 50.

[0355] The aerosol-generating article 10 has an overall length of about 45 millimetres and an outer diameter of about 7.7 mm.

[0356] The aerosol-generating rod has a length of 11 millimetres. The aerosol-generating rod comprises a core portion 20, which comprises a shredded tobacco material. In more detail, the core portion 20 comprises a homogenised tobacco material in the form of a sheet gathered into a cylindrical shape, the homogenised tobacco material comprising from 13 percent by weight to 16 percent by weight of glycerine. An average porosity of the core portion is about 0.3. The aerosol-generating article 10 further comprises an elongate susceptor element 22 in the form of a plate embedded in, and thermally coupled with, the aerosol-generating substrate in the core portion 20.

[0357] The aerosol-generating rod further comprises an annular portion 24, which surrounds and radially abuts the core portion 20. Thus, as shown in FIG. 2, an internal diameter of the annular portion 24 substantially matches and outer diameter of the core portion.

[0358] An average porosity of the annular portion is 0.6. The annular portion is formed of a plurality of linear, axially oriented fibres of cellulose acetate.

[0359] The hollow tubular element 30 has a length of about 12 millimetres, an external diameter of about 7.7 millimetres, and an internal diameter of about 5.5 millimetres. Thus, a thickness of a peripheral wall of the hollow tubular element 30 is about 1.1 millimetres.

[0360] The hollow tubular element 30 defines an internal cavity 32 that extends all the way from an upstream end of the hollow tubular element 30 to a downstream end of the hollow tubular element 30. The internal cavity 32 is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity 32. The hollow tubular element 30 does not substantially contribute to the overall RTD of the aerosol-generating article 10.

[0361] Because the internal diameter of the hollow tubular element 30 is larger than an internal diameter of the annular portion 22, the annular portion 22 is in direct fluid communication with the internal cavity 32.

[0362] The aerosol-generating article 10 comprises a ventilation zone 40 provided at a location along the hollow tubular element 30. In more detail, the ventilation zone 40 is provided at about 26 millimetres from a downstream end of the article 10. The ventilation zone 40 is provided 4 mm upstream from an upstream end of the mouthpiece element 50. The ventilation zone 40 comprises a circumferential row of openings or perforations circumscribing the hollow tubular element 30. The perforations of the ventilation zone 40 extend through the wall of the hollow tubular element 30, in order to allow fluid ingress into the internal cavity 32 from the exterior of the article 10. A ventilation level of the aerosol-generating article 10 is about 16 percent.

[0363] The mouthpiece element 50 extends from the downstream end of the hollow tubular element 30 to the downstream or mouth end of the aerosol-generating article 10. The mouthpiece element 50 has a length of about 22 mm. An external diameter of the mouthpiece element 50 is about 7.7 mm. The mouthpiece element 50 comprises a low-density, cellulose acetate filter segment. The RTD of the mouthpiece element 50 is about 8 mm H₂O. The mouthpiece element 50 may be individually wrapped by a plug wrap (not shown).

[0364] The aerosol-generating article further comprises an elongate susceptor 60 in the form of a rectangular strip provided within the core portion 20.

[0365] FIG. 3 illustrates an aerosol-generating system 100 comprising an exemplary aerosol-generating device 1 and the aerosol-generating article 10, equivalent to that shown in FIGS. 1 and 2. In particular, FIG. 3 illustrates a downstream, mouth end portion of the aerosol-generating device 1 where the device cavity is defined and the aerosol-generating article 10 can be received.

[0366] The aerosol-generating device 1 comprises a housing (or body) 4. The housing 4 comprises a peripheral wall 6 and an end wall 8. The peripheral wall 6 defines a device cavity for receiving an aerosol-generating article 10. The device cavity is defined by a closed, distal end and an open, mouth end. The mouth end of the device cavity is located at

the mouth end of the aerosol-generating device 1. The aerosol-generating article 10 is configured to be received through the mouth end of the device cavity and is configured to abut a closed end of the device cavity.

[0367] A device airflow inlet 5 is defined within the end wall 8. Air may enter the core portion 20 via the device airflow inlet 5, as illustrated by the dotted arrows in FIG. 3. At the same time, because a diameter of the device airflow inlet 5 is smaller than the outer diameter of the core portion 20, the end wall 8 effectively occludes an end surface of the annular portion. As such, a fluid communication is selectively established between an exterior of the aerosol-generating device 1 and the aerosol-generating substrate in the core portion 20, while airflow into the annular portion is disabled.

[0368] The aerosol-generating device 1 further comprises a heater element in the form of an inductor coil 7 adapted to induce a current in the susceptor element 24. The aerosol-generating device 1 further comprises a power source (not shown) for supplying power to the heater. A controller (not shown) is also provided to control such supply of power to the heater. The heater is configured to controllably heat the aerosol-generating article 10 during use, when the aerosol-generating article 1 is received within the device 1.

[0369] 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 percent 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.

1.-15. (canceled)

16. An aerosol-generating article, comprising:

an aerosol-generating rod extending from an upstream end to a downstream end; and

a downstream section provided downstream of the aerosol-generating rod and abutting the downstream end of the aerosol-generating rod,

wherein the aerosol-generating rod comprises a substantially cylindrical core portion having a longitudinal axis and an annular portion surrounding and extending coaxially with the core portion,

wherein the annular portion is air permeable, such that an upstream end of the annular portion internal is in fluid communication with the downstream section,

wherein the core portion comprises an aerosol-generating substrate and has a cross-sectional porosity of from 0.10 to 0.45,

wherein a cross-sectional porosity of the annular portion is at least 120 percent of the cross-sectional porosity of the core portion, and

wherein a thickness of the annular portion is at least 0.5 millimetre.

17. The aerosol-generating article according to claim **16**, wherein the downstream section comprises a hollow tubular element, the hollow tubular element defining an internal cavity and abutting the downstream end of the aerosol-generating rod.

18. The aerosol-generating article according to claim **17**, wherein an internal diameter of the annular portion is smaller than an internal diameter of the hollow tubular element.

19. The aerosol-generating article according to claim **17**, wherein the downstream section further comprises a mouthpiece element downstream of the hollow tubular element, and

wherein the aerosol-generating article further comprises a wrapper circumscribing the aerosol-generating rod, the hollow tubular element, and the mouthpiece.

20. The aerosol-generating article according to claim **17**, further comprising a ventilation zone at a location along the hollow tubular element.

21. The aerosol-generating article according to claim **16**, wherein the annular portion comprises linear, axially oriented fibres.

22. The aerosol-generating article according to claim **21**, wherein the linear, axially oriented fibres are selected from: cellulose acetate fibres, poly lactic acid (PLA) fibres, polypropylene fibres, poly(3-hydroxybutyrate-co-hydroxyvalerate) (PHVB) fibres, rayon fibres, viscose fibres, regenerated cellulose fibres, and combinations thereof.

23. The aerosol-generating article according to claim **21**, wherein the annular portion further comprises two or more longitudinal segments of tow material, and the tow material

of adjacent ones of the two or more longitudinal segments is bonded together at least along longitudinal edges of the segments to form an integral annular portion.

24. The aerosol-generating article according to claim **21**, wherein the fibres have a denier per filament (dpf) from 3.0 dpf to 15.0 dpf.

25. The aerosol-generating article according to claim **16**, wherein the core portion has a cross-sectional porosity of from 0.15 to 0.30.

26. The aerosol-generating article according to claim **16**, wherein the core portion has a cross-sectional porosity distribution of from 0.04 to 0.22.

27. The aerosol-generating article according to claim **16**, wherein the annular portion has a cross-sectional porosity of from 0.3 to 0.95.

28. The aerosol-generating article according to claim **16**, further comprising a susceptor element arranged within the core portion and thermally coupled with the aerosol-generating substrate.

29. The aerosol-generating article according to claim **16**, wherein the annular portion radially abuts the core portion.

30. An aerosol-generating system comprising an aerosol-generating article according to claim **16** and an aerosol-generating device comprising a heating chamber open at a proximal end configured to at least partly receive the aerosol-generating rod to heat the aerosol-generating substrate, the aerosol-generating device further comprising an opening at a distal end configured to admit airflow into the heating chamber along a longitudinal axis of the heating chamber, wherein a diameter of the opening is smaller than the internal diameter of the annular portion.

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