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(54) AEROSOL-GENERATING ARTICLE HAVING A THERMAL INDICATOR

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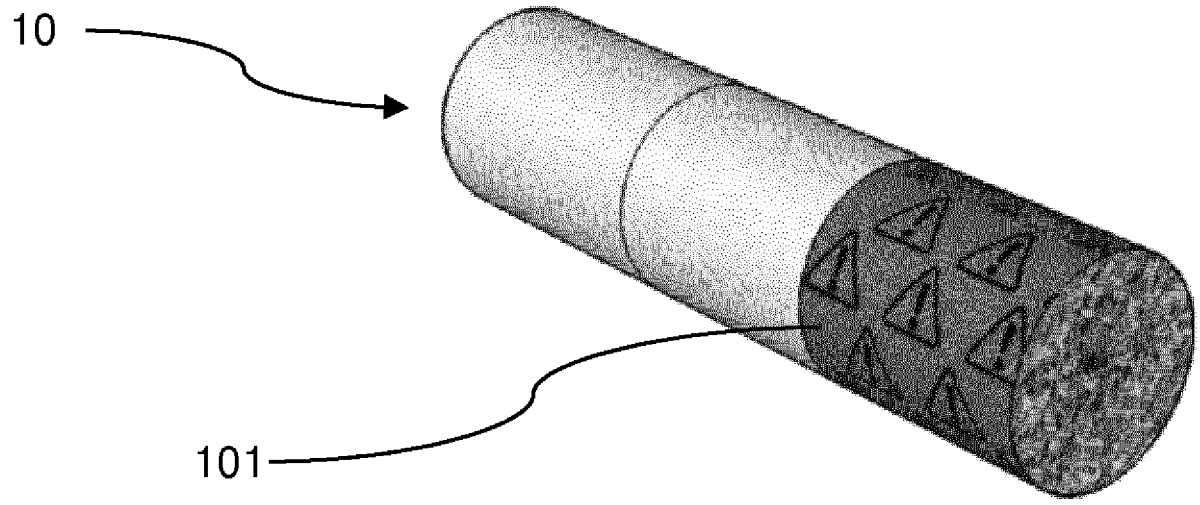
(57) **ABSTRACT**

An aerosol-generating article for an aerosol-generating device having a heating element is provided, the article including: a rod of aerosol-generating substrate formed of an aerosol-forming material having an aerosol former content of between 5 percent and 30 percent on a dry weight basis; and an outer wrapper wrapped around at least a portion of the rod, and at least a portion of an outer surface of the wrapper includes a thermal indicator including a thermochromic material, at least a portion of which is configured to undergo a visual change when a temperature at the portion exceeds a threshold temperature, such that the outer wrapper provides a visual indication that a temperature at the thermal indicator has exceeded the threshold temperature, the threshold temperature being at least about 175° C.



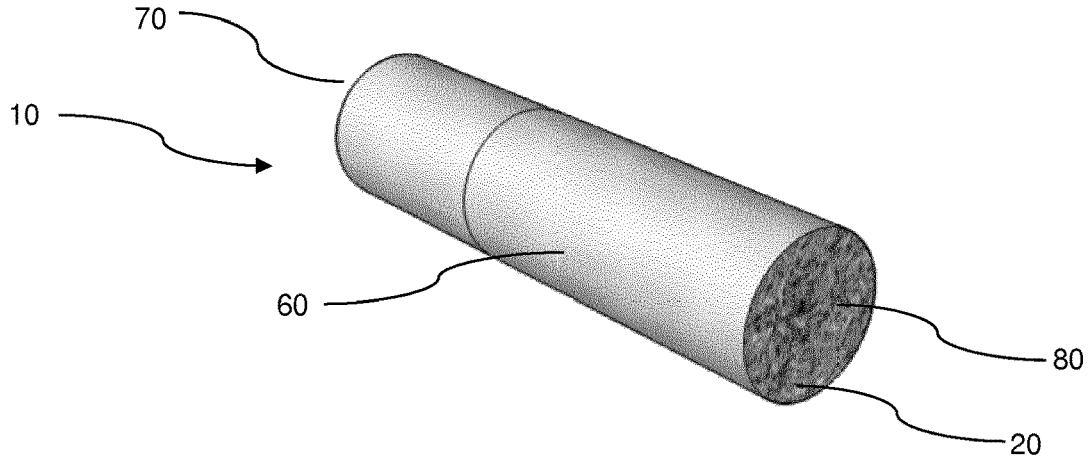


Figure 1

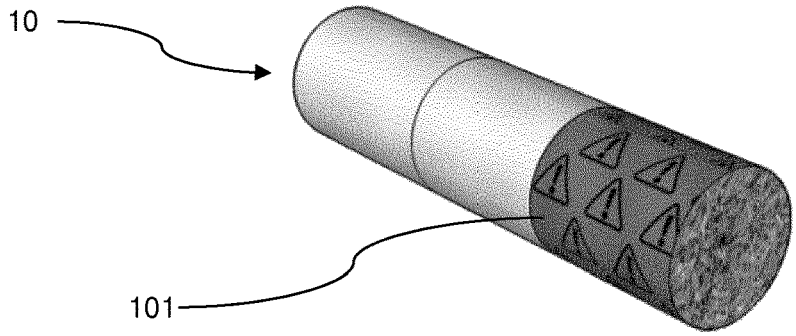


Figure 2

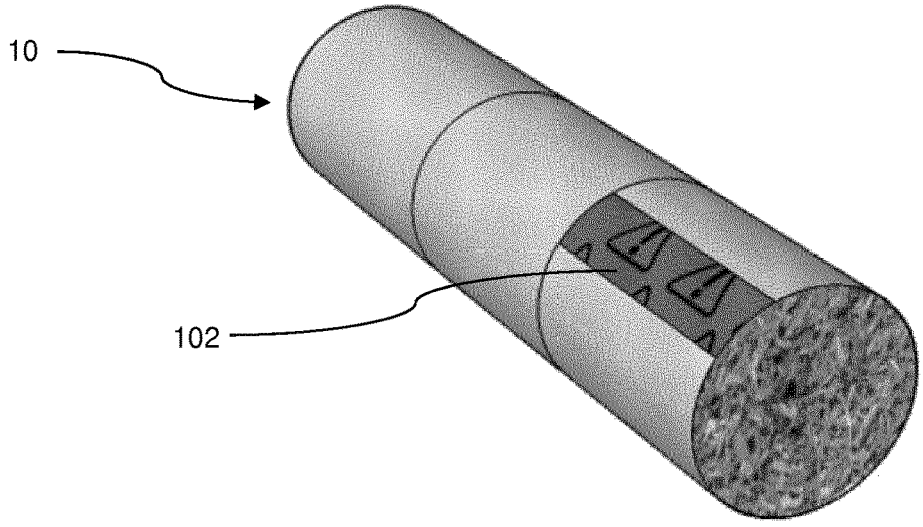


Figure 3

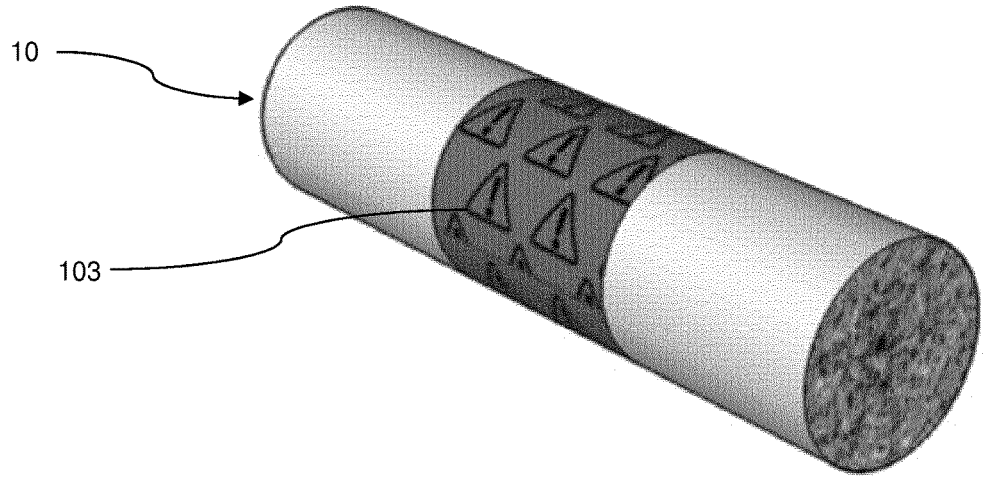


Figure 4

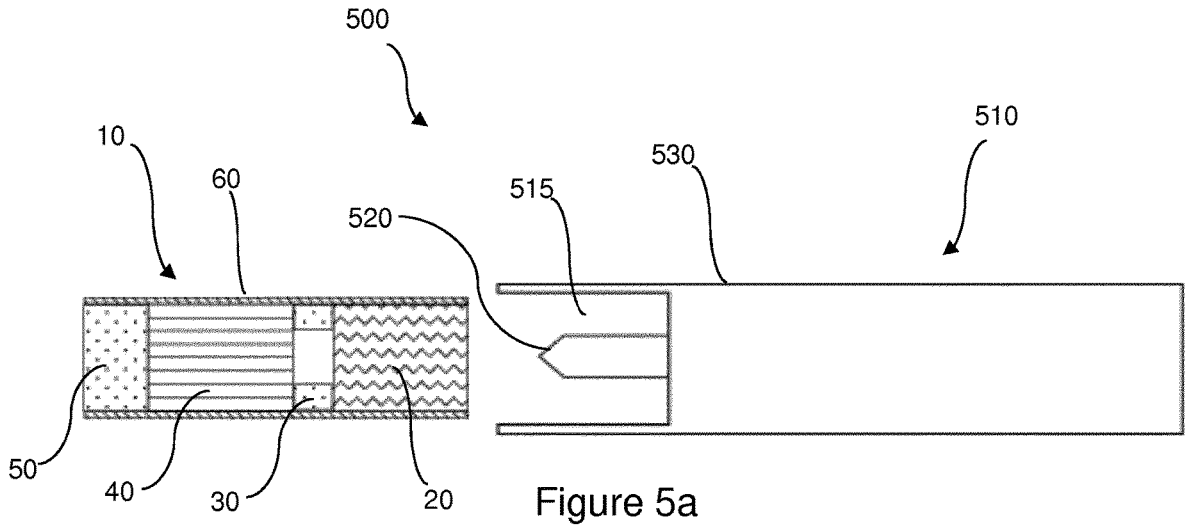


Figure 5a

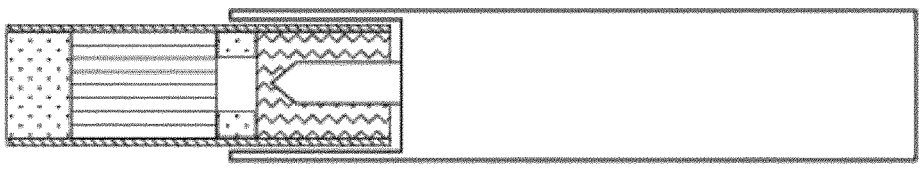


Figure 5b

AEROSOL-GENERATING ARTICLE HAVING A THERMAL INDICATOR

[0001] The present invention relates to a heated aerosol-generating article incorporating a thermal indicator comprising a thermochromic material, to the use of such thermochromic material in such a heated aerosol-generating article and to an aerosol-generating system comprising such a heated aerosol-generating article having a thermal indicator.

[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 or smoking heated 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 heating elements of the aerosol-generating device to the aerosol-generating substrate of a heated aerosol-generating article. One advantage of such electrically heated aerosol-generating devices is that they significantly reduce sidestream smoke.

[0004] In such aerosol-generating devices, the heating element will typically be configured to heat the aerosol-generating substrate within a defined temperature range which has been selected by the manufacturer to provide an optimal aerosol release profile from the aerosol-generating article. The aerosol-generating article and aerosol-generating device are therefore specifically adapted for use in conjunction with each other.

[0005] However, where an aerosol-generating article is inadvertently or intentionally used with an incompatible aerosol-generating device, an optimal aerosol release profile is very unlikely to be provided to the consumer. The construction of the heating element in the incompatible device will typically be different to that of the compatible device and the form of heating of the aerosol-generating substrate is therefore likely to be different. Furthermore, the heater may not be operated in the same way within the same temperature ranges, so that the aerosol-generating substrate will not be heated under the same temperature profile as in a compatible device. As a result, the properties of the aerosol released from the substrate will not be as intended by the manufacturer. The experience of the consumer will likely therefore be adversely affected as a result of using the aerosol-generating article with an incompatible device.

[0006] Particular problems may arise when an aerosol-generating article is used in a device that heats the aerosol-generating substrate to a higher temperature than intended, such that at least a part of the substrate becomes overheated. This may occur, for example, when an aerosol-generating article that is adapted to be heated by an internal heating element is instead used in an aerosol-generating device that heats the aerosol-generating article externally. Such devices that heat the substrate from the outside during use typically require much higher operating temperatures and therefore at least the outer parts of the substrate are likely to be heated to a much higher temperature than would be provided using an internal heating element. Additionally, overheating of the substrate may also occur from internal heating of the aerosol-generating article to also much higher operating temperatures by a compatible or in-compatible aerosol-generating device that heats the aerosol-generating article internally.

[0007] It would be desirable to provide a novel arrangement of an aerosol-generating article which provides a visual indication or warning to a user of the use of the aerosol-generating article with an incompatible aerosol-generating device and in particular, with any aerosol-generating device that heats the aerosol-generating substrate to a higher temperature than is intended for the substrate. It would be further desirable to provide such a novel arrangement of an aerosol-generating article which does not adversely impact the use of the aerosol-generating article under normal heating conditions in a compatible device. It would be particularly desirable if such a novel arrangement of an aerosol-generating article could be readily provided without significantly impacting the construction of the aerosol-generating article or the method and apparatus used for the production of the aerosol-generating article.

[0008] According to a first aspect of the present invention, there is provided a heated aerosol-generating article for use with an aerosol-generating device having a heating element, the heated aerosol-generating article comprising: a rod of aerosol-generating substrate; and an outer wrapper, wherein the outer wrapper is wrapped around at least a portion of the rod of aerosol-generating substrate and at least a portion of an outer surface of the wrapper comprises a thermal indicator. The thermal indicator comprises a thermochromic material, whereby at least a portion of the thermochromic material is adapted to undergo a visual change when the temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that the temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 175° C.

[0009] According to a second aspect of the present invention, there is provided a heated aerosol-generating article for use with an aerosol-generating device having a heating element, the heated aerosol-generating article comprising: a rod of aerosol-generating substrate; and an outer wrapper, wherein at least a portion of an outer surface of the wrapper comprises a thermal indicator, wherein the thermal indicator is located downstream of the rod of aerosol-generating substrate. The thermal indicator comprises a thermochromic material, whereby at least a portion of the thermochromic material is adapted to undergo a visual change when the temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that the temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 115° C.

[0010] According to a third aspect of the present invention, there is provided a use of thermochromic material in a thermal indicator located on an outer wrapper of a rod of aerosol-generating substrate of a heated aerosol-generating article, the heated aerosol-generating article being configured to be used with an aerosol-generating device having a

heating element, wherein the outer wrapper is wrapped around at least a portion of the rod of aerosol-generating substrate and whereby at least a portion of the thermochromic material is adapted to undergo a visual change when the temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that the temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 175° C.

[0011] According to a fourth aspect of the present invention, there is provided a use of thermochromic material in a thermal indicator located on an outer wrapper of a heated aerosol-generating article, the heated aerosol-generating article being configured to be used with an aerosol-generating device having a heating element and the heated aerosol-generating article comprising a rod of aerosol-generating substrate, whereby the thermal indicator is located downstream of the rod of aerosol-generating substrate and at least a portion of the thermochromic material is adapted to undergo a visual change when the temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that the temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 115° C.

[0012] According to a fifth aspect of the present invention, there is provided an aerosol-generating system comprising: a heated aerosol-generating article according to the first or second aspects of the present invention as described above; and an aerosol-generating device adapted to receive the heated aerosol-generating article. The aerosol-generating device comprises a heater element configured to heat the rod of aerosol-generating material during use wherein the heater element is controlled during use to operate below a maximum operating temperature. The thermal indicator of the heated aerosol-generating article is adapted such that the threshold temperature is not exceeded during use of the aerosol-generating system with the heater element operating below the maximum operating temperature.

[0013] As used herein, the term "heated aerosol-generating article" refers to an aerosol-generating article for producing an aerosol comprising an aerosol-generating substrate that is intended to be heated rather than combusted in order to release volatile compounds that can form an aerosol. Such articles are commonly referred to as "heat-not-burn" products.

[0014] As used herein, the term "aerosol-generating substrate" refers to a substrate capable of releasing upon heating volatile compounds, which can form an aerosol. The aerosol generated from aerosol-generating substrates of aerosol-generating articles described herein may be visible or invisible and may include vapours (for example, fine particles of substances, which are in a gaseous state, that are ordinarily liquid or solid at room temperature) as well as gases and liquid droplets of condensed vapours.

[0015] As used herein, the term "rod" refers to a generally cylindrical element of substantially polygonal cross-section and preferably of circular, oval or elliptical cross-section. The term "article" will refer to an aerosol-generating article, unless otherwise stated.

[0016] 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. 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.

[0017] 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.

[0018] Aerosol-generating articles according to the present invention are suitable for use in an aerosol-generating system comprising an electrically heated aerosol-generating device having an internal heating element for heating the aerosol-generating substrate. 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 European patent application EP-A-0 822 670.

[0019] As used herein, the term "aerosol-generating device" refers to a device comprising a heating element that interacts with the aerosol-generating substrate of the aerosol-generating article to generate an aerosol.

[0020] As described above, aerosol-generating articles according to the present invention incorporate an outer wrapper comprising a thermal indicator. The thermal indicator provides an effective means for warning and preventing use of an aerosol-generating article according to the present invention in an incompatible device that heats the aerosol-generating article excessively above a desired operating temperature. Upon overheating of the rod of aerosol-generating substrate, the thermal indicator will produce a visual change to warn the user of incorrect and/or potentially harmful use, which the user may see during or after use of the aerosol-generating article. In this way the user will be alerted to the fact that they have used or are using the aerosol-generating article with an incompatible device, or with a compatible device that is malfunctioning and overheating the aerosol-generating article during use. The thermal indicator therefore provides means for prevention of overheating of the aerosol-generating article.

[0021] As used herein with reference to the invention, the term "thermochromic material" is used to describe any material that undergoes a visual change at a predetermined threshold temperature or range of temperatures.

[0022] Thermochromic material may undergo a visual change as the temperature rises above or falls below the threshold temperature. As used herein with reference to the invention, the term "threshold temperature" is used to describe the temperature after which the visual change of a thermochromic material is substantially complete.

[0023] Advantageously, the thermal indicator is adapted so that it will undergo a visual change at excessive operating temperatures. Therefore, when the aerosol-generating articles according to the present invention are heated normally in a compatible aerosol-generating device, the presence of the thermal indicator will not perceivably impact the consumer experience. In particular, the presence of the thermal indicator does not adversely impact the resistance to draw (RTD) of the aerosol-generating article.

[0024] The outer wrapper comprising a thermal indicator can be conveniently incorporated into an aerosol-generating

article without significantly impacting the arrangement of the other components of the article. The inclusion of the thermal indicator should not therefore significantly impact the manufacture of the aerosol-generating articles. Aerosol-generating articles according to the invention can therefore advantageously be made using existing high speed methods and apparatus, with only minor modifications.

[0025] The positioning of the thermal indicator on the outer wrapper, surrounding the outside of the aerosol-generating article, and the material selected for the thermal indicator determine the responsiveness of the thermal indicator to overheating of the aerosol-generating article due to use in an incompatible device having, for example, a peripheral heater that heats the aerosol-generating substrate externally.

[0026] In the event that the aerosol-generating article is overheated, for example in an incompatible device, so that the thermal indicator reaches its threshold temperature, the thermal indicator will be "activated" and undergo a visual change. The activation of the thermal indicator will therefore provide an effective means for warning and preventing use of an aerosol-generating article according to the present invention in an incompatible device that heats the aerosol-generating article excessively above a set of desired operating temperatures and above the threshold temperature.

[0027] The "threshold temperature" of the thermal indicator corresponds to the temperature at which the thermal indicator will undergo a visual change, as described above. This will typically correspond to the threshold temperature of the material used to form the thermal indicator. As discussed in more detail below, the threshold temperature of and at the thermal indicator will be selected so that it will only be reached or exceeded when the aerosol-generating article is overheated, that is, heated above the intended operating temperature range. The threshold temperature will therefore correspond to the temperature reached at the thermal indicator when the aerosol-generating substrate is heated above the maximum desired temperature, as determined by the manufacturer.

[0028] There are several potential ways in which the thermal indicator may be adapted so that activation occurs at the desired threshold temperature and so that the visual change is produced at the thermal indicator to prevent further use of the aerosol-generating article.

[0029] A suitable material should be selected for forming the thermal indicator, wherein the material has an appropriate activation point or threshold temperature to ensure that there is no risk of the thermal indicator undergoing a visual change when the aerosol-generating article is heated to within a normal operating temperature range but also so that the thermal indicator does effectively undergo a visual change when the aerosol-generating article is overheated to a temperature above this range. This would avoid erroneous indications of overheating when the aerosol-generating indicator operates within a normal operating temperature range and provide a reliable overheating indicator when the aerosol-generating indicator does operate outside or above a normal operating temperature range.

[0030] A suitable position of the thermal indicator on the aerosol-generating article will also need to be selected. The appropriate position for the thermal indicator will depend to an extent upon the selected material so that the threshold temperature can be defined appropriately. This will avoid the unintended activation of the thermal indicator during normal use of the aerosol-generating article.

[0031] Typically, during use, the aerosol-generating article will be inserted into an aerosol-generating device such that the aerosol-generating substrate is heated, either directly or indirectly, by a heating element within the device. The temperature within the aerosol-generating article will be highest adjacent to the heating element and will decrease longitudinally along the aerosol-generating article with increasing distance from the heating element. The appropriate threshold temperature for the thermal indicator will therefore vary depending on how far the thermal indicator is placed downstream from the aerosol-generating substrate. In particular, the further the thermal indicator is placed downstream of the aerosol-generating substrate, the lower the threshold temperature will need to be in order for the thermal indicator to activate.

[0032] The temperature profile within and surrounding an aerosol-generating article can be readily measured using thermocouples such that an appropriate threshold temperature can be determined to ensure that the thermal indicator is activated only when the substrate is deemed to be overheated, above a defined maximum temperature.

[0033] The thermal indicator may be suitably located anywhere on the outer surface of the outer wrapper. The thermal indicator may at least be adjacent to and/or around the rod of aerosol-generating substrate.

[0034] As discussed above, the threshold temperature of the thermal indicator according to the present invention is selected depending on its location along the aerosol-generating article, which has a preferred range of operating temperatures.

[0035] Advantageously, the threshold temperature may be below about 300° C.

[0036] Advantageously, the threshold temperature may be between about 115° C. and about 300° C. For example, the threshold temperature may be between about 120° C. and about 300° C. For example, the threshold temperature may be between about 155° C. and about 300° C. For example, the threshold temperature may be between about 160° C. and about 300° C. For example, the threshold temperature may be between about 170° C. and about 300° C. For example, the threshold temperature may be between about 175° C. and about 300° C.

[0037] Advantageously, the threshold temperature may be below about 275° C.

[0038] Advantageously, the threshold temperature may be between about 115° C. and about 275° C. For example, the threshold temperature may be between about 120° C. and about 275° C. For example, the threshold temperature may be between about 155° C. and about 275° C. For example, the threshold temperature may be between about 160° C. and about 275° C. For example, the threshold temperature may be between about 170° C. and about 275° C. For example, the threshold temperature may be between about 175° C. and about 275° C.

[0039] Advantageously, the threshold temperature may be below about 250° C.

[0040] Advantageously, the threshold temperature may be between about 115° C. and about 250° C. For example, the threshold temperature may be between about 120° C. and about 250° C. For example, the threshold temperature may be between about 155° C. and about 250° C. For example, the threshold temperature may be between about 160° C. and

about 250° C. For example, the threshold temperature may be between about 170° C. and about 250° C. For example, the threshold temperature may be between about 175° C. and about 250° C.

[0041] In accordance with the first aspect of the invention, the thermal indicator may be located around at least a portion of the rod of aerosol-generating substrate. The thermal indicator may circumscribe and cover the entirety of the surface area of rod of aerosol-generating substrate. Alternatively or in addition, the thermal indicator may circumscribe at least a portion of the rod of aerosol-generating substrate and, at least, another downstream portion of the aerosol-generating article. Alternatively, the thermal indicator may circumscribe only a portion of the overall circumference or periphery of the aerosol-generating article, preferably around the rod of aerosol-generating substrate.

[0042] In accordance with the first aspect of the invention, the thermal indicator is provided over the rod of aerosol-generating substrate and the threshold temperature is preferably at least about 175° C., more preferably about 180° C. and most preferably about 185° C. Preferably, the threshold temperature is at least about 220° C. The threshold temperature may be no more than about 300° C. This ensures that the thermal indicator is sufficiently sensitive to heating of the aerosol-generating substrate above the maximum desired temperature. In such embodiments, the threshold temperature of the thermal indicator will need to be relatively high due to the likely proximity to the heating element of the aerosol-generating device during use.

[0043] In accordance with a second aspect of the present invention, the thermal indicator may be located downstream from the rod of aerosol-generating substrate, or the "substrate/distal end" of the aerosol-generating article. As used herein with reference to the invention, the term "substrate/distal end" refers to the upstream end of the aerosol-generating article, also being the end of the aerosol-generating substrate which is configured to be heated. The "mouthpiece end" of the aerosol-generating article is the downstream end of the aerosol-generating article, opposite the "substrate/distal end".

[0044] In accordance with the second aspect of the invention, the thermal indicator, or a portion thereof, is provided downstream of the rod of aerosol-generating substrate, the threshold temperature is preferably at least about 115° C., more preferably about 120° C. and most preferably about 125° C. The threshold temperature may be no more than about 200° C. This ensures that the thermal indicator is sufficiently sensitive to heating of the aerosol-generating substrate above the maximum desired temperature. In such embodiments, the threshold temperature of the thermal indicator will need to be lower due to the likely greater distance to the heating element of the aerosol-generating device during use.

[0045] In accordance with all aspects of the present invention, the thermal indicator extends longitudinally along at least part of the length of the aerosol-generating article. For example, the length of the thermal indicator may be between about 1 mm and 20 mm. Moreover, the length of the thermal indicator may be between about 1 mm and 15 mm.

[0046] The thermal indicator may extend longitudinally along at least 20% of the length of the aerosol-generating article, more preferably at least 25% of the length of the aerosol-generating article. Preferably, the thermal indicator may extend longitudinally along at least 50% of the length of the aerosol-generating article.

[0047] The length of the thermal indicator may be the same length as the aerosol-generating article, or may be the same length as the rod of aerosol-generating substrate. Preferably, the length of the thermal indicator may be at least 75% of the length of the rod of aerosol-generating substrate, and more preferably at least 50% of the length of the rod of aerosol-generating substrate.

[0048] The thermal indicator may extend circumferentially at least partially around the aerosol-generating article. Preferably, the thermal indicator extends around the entire circumference of the aerosol-generating article.

[0049] In accordance with the first aspect of the invention, the thermal indicator may overlie at least 1 mm^2 of the external surface area of the rod of aerosol-generating substrate. Preferably, the thermal indicator may overlie at least 5 mm^2 of the external surface area of the rod of aerosol-generating substrate.

[0050] In accordance with the first aspect of the invention, the thermal indicator may overlie at least 20% of the external surface area of the rod of aerosol-generating substrate. Preferably, the thermal indicator may overlie at least 25% of the external surface area of the rod of aerosol-generating substrate. Preferably, the thermal indicator may overlie at least 50% of the external surface area of the rod of aerosol-generating substrate.

[0051] In certain embodiments according to the first aspect of the invention, the thermochromic material may be arranged such that the visual change occurs only within a circumferential portion of the outer wrapper, wherein the circumferential portion may extend only partially around the circumference of the aerosol-generating article. In such embodiments, the thermal indicator may be adapted to provide a localised visual change, at a specific circumferential position around the aerosol-generating article, preferably at a specific circumferential position around the rod of aerosol-generating substrate. For example, a circumferential portion of the outer surface of the wrapper may comprise the thermal indicator, or a circumferential portion of the thermal indicator may be configured to undergo a visual change, or both. The circumferential portion may extend at least 5% of the circumference of the article, more preferably at least 10% of the circumference of the article and most preferably at least 20% of circumference of the article. In such embodiments, the threshold temperature is preferably at least about 175° C., more preferably about 180° C. and most preferably about 185° C. Preferably, the threshold temperature is at least about 220° C. The threshold temperature may be no more than about 300° C. This ensures that the thermal indicator is sufficiently sensitive to overheating of the aerosol-generating substrate above the maximum desired temperature. The temperature distribution along and/or across the rod of substrate when heated may not be uniform and therefore local portions of the outer surface of the rod of aerosol-generating substrate may be overheated and other portions may not be overheated. In such embodiments, the threshold temperature of the thermal indicator will also need to be relatively high due to the likely proximity the thermal indicator to the heating element of the aerosol-generating device during use. The localised visual change may also provide an indication of, in addition to localised overheating of the substrate, the alignment of a heating element of an aerosol-generating device with respect to the outer wrapper

and rod of aerosol-generating substrate. If the heating element is configured to heat the substrate internally, then the threshold temperature may be such that the localised visual change may indicate that the region of the outer wrapper where the localised visual change has occurred is likely to be closest to the heat element.

[0052] As discussed above, for all aspects of the invention, the thermal indicator is configured to undergo a visual change when a threshold temperature is exceeded. As discussed above, the visual change may occur over a portion of or the entirety of the thermal indicator depending on which portions of the thermal indicator have exceeded their respective threshold temperatures. The visual change may involve changing from a first colour to a second colour or from substantially colourless to a first colour or from a first colour to substantially colourless. The visual change may involve changing from a first colour, to a second colour and then to a third colour. The visual change may involve transitioning from substantially colourless through a plurality of different colours to a final colour. The visual change may involve transitioning from an initial colour through a plurality of different colours to a final colour. Each colour may provide a particular indication of the degree of overheating in the substrate. The visual change may comprise the thermal indicator not displaying any warning indicia or messages to displaying warning indicia or messages. The warning indicia or messages may comprise logos or any form of graphical representation.

[0053] The visual change may be instantaneous or gradual over a broad transition range of colour.

[0054] Advantageously, the visual change may be irreversible or reversible, more preferably irreversible. The visual change of the thermal indicator being irreversible or substantially permanent allows the thermal indicator to suitably convey the message of misuse of the aerosol-generating article to the user at a time after the visual change occurs. The temperature at the thermal indicator may exceed the threshold temperature before the user or consumer finishes with the article. Therefore, an irreversible visual change is advantageous for ensuring that the user is informed of the misuse after they finish with the article.

[0055] The visual change may encompass any combination of characteristics described above.

[0056] The thermal indicator may comprise a single thermochromic material with a specific threshold temperature and visual change. Alternatively, the thermal indicator may comprise a plurality of different thermochromic materials, wherein each of the different thermochromic materials may comprise a different threshold temperature and/or visual change to each other.

[0057] The thermal indicator may comprise a single thermochromic material wherein the threshold temperature is uniform across and along the thermal indicator. Alternatively, the thermal indicator may comprise a single thermochromic material wherein the threshold temperature varies either longitudinally and/or along the thermal indicator. For example, the threshold temperature may decrease or increase in the downstream or upstream direction along the thermal indicator.

[0058] In all embodiments of the present invention, the thermal indicator is formed of thermochromic material. The thermochromic material may be applied or affixed onto the surface of the outer wrapper, in the form of paint, ink, dye or another layer of material having thermochromic material applied thereon. Alternatively, the outer wrapper may comprise temperature indicating sensor paper, whereby the thermochromic material is integral to the temperature indicating sensor paper. The thermochromic material may further be integral to at least any other component, layer or portion of the outer wrapper.

[0059] THERMEX® by Sensor Products Inc. (http://www.sensorprod.com/thermex.php) is an example of an irreversible thermochromic material suitable for use in providing the thermal indicator of the present invention. THERMEX® is a tactile surface temperature indicating material provided as sheet material and configured to be placed between two contacting surfaces, and upon exposure to a particular threshold temperature or range of threshold temperatures, the THERMEX® sheet instantaneously and permanently changes colour. The colour change is permanent or irreversible and the operational range of threshold temperatures is of 90 to 149° C. Other suitable irreversible thermochromic materials generally known to the skilled person may be used.

[0060] The thermal indicator may comprise a combination of reversible and irreversible thermochromic materials. In such cases, the thermal indicator may undergo both reversible and irreversible visual changes. Suitable reversible thermochromic materials generally known to the skilled person may be used.

[0061] As discussed before, the thermal indicator could be readily provided without significantly impacting the construction of the aerosol-generating article or the method and apparatus used for the production of the aerosol-generating article. The thermal indicator may therefore easily be disposed on or applied or affixed to the inner and/or outer surfaces of the outer wrapper, preferably to or on the outer surface of the outer wrapper. The thermal indicator may be disposed between two layers of wrapping material which may form the outer wrapper. The thermal indicator may be incorporated into the outer wrapper in a separate process so that the process of assembling the outer wrapper around the article is unaffected.

[0062] The aerosol-generating articles according to the present invention may comprise a plurality of elements, including the rod of aerosol-generating substrate and the thermal indicator located on the outer wrapper of the article. The outer wrapper may comprise a cigarette paper.

[0063] Aerosol-generating articles commonly comprise a hollow acetate tube directly adjacent to the aerosol-generating substrate.

[0064] The rod of aerosol-generating substrate is formed of an aerosol-forming material, which is particularly preferably homogenised tobacco material.

[0065] As used herein, the term "homogenised tobacco material" encompasses any tobacco material formed by the agglomeration of particles of tobacco material. Sheets or webs of homogenised tobacco material are formed by agglomerating particulate tobacco obtained by grinding or otherwise powdering of one or both of tobacco leaf lamina and tobacco leaf stems. In addition, homogenised tobacco material may comprise a minor quantity of one or more of tobacco dust, tobacco fines, and other particulate tobacco by-products formed during the treating, handling and shipping of tobacco. The sheets of homogenised tobacco material may be produced by casting, extrusion, paper making processes or other any other suitable processes known in the art.

[0066] In preferred embodiments, the rod comprises one or more sheets of a homogenised tobacco material that have been gathered to form a plug and circumscribed by an outer wrapper. 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. As used herein with reference to the invention, the term "gathered" describes a sheet that is convoluted, folded, or otherwise compressed or constricted substantially transversely to the longitudinal axis of the aerosol-generating article.

[0067] Advantageously, the aerosol-generating substrate comprises a gathered textured sheet of homogenised tobacco material. As used herein with reference to the invention, the term "textured sheet" describes a sheet that has been crimped, embossed, debossed, perforated or otherwise deformed.

[0068] Use of a textured sheet of homogenised tobacco material may advantageously facilitate gathering of the sheet of homogenised tobacco material to form the aerosol-generating substrate.

[0069] The aerosol-generating substrate may comprise a gathered textured sheet of homogenised tobacco material comprising a plurality of spaced-apart indentations, protrusions, perforations or any combination thereof.

[0070] In certain preferred embodiments, the aerosol-generating substrate comprises a gathered crimped sheet of homogenised tobacco material. As used herein with reference to the invention, the term "crimped sheet" describes a sheet having a plurality of substantially parallel ridges or corrugations. Advantageously, when the aerosol-generating article has been assembled, the substantially parallel ridges or corrugations extend along or parallel to the longitudinal axis of the aerosol-generating article. This facilitates gathering of the crimped sheet of homogenised tobacco material to form the aerosol-generating substrate.

[0071] However, it will be appreciated that crimped sheets of homogenised tobacco material for inclusion in the aerosol-generating substrates of aerosol-generating articles according to the invention may alternatively or in addition have a plurality of substantially parallel ridges or orrugations that are disposed at an acute or obtuse angle to the longitudinal axis of the aerosol-generating article when the aerosol-generating article has been assembled.

[0072] Sheets of homogenised tobacco material for use in 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.

[0073] Preferably, the sheets of homogenised tobacco material comprise an aerosol former. The sheets of homogenised tobacco material may comprise a single aerosol former. Alternatively, the sheets of homogenised tobacco material may comprise a combination of two or more aerosol formers.

[0074] Suitable aerosol-formers are known in the art and include, but are not limited to: monohydric alcohols like menthol, polyhydric alcohols, such as triethylene glycol, 1,3-butanediol and glycerine; esters of polyhydric alcohols, such as glycerol mono-, di- or triacetate; and aliphatic esters of mono-, di- or polycarboxylic acids, such as dimethyl dodecanedioate, dimethyl tetradecanedioate, erythritol, 1,3-butylene glycol, tetraethylene glycol, triethyl citrate, propylene carbonate, Ethyl laurate, triacetin, meso-erythritol, a diacetin mixture, a diethyl suberate, triethyl citrate, benzyl benzoate, benzyl phenyl acetate, ethyl vanillate, tributyrin, lauryl acetate, lauric acid, myristic acid, and propylene glycol.

[0075] Preferably, the sheets of homogenised tobacco material have an aerosol former content of greater than 5 percent on a dry weight basis.

[0076] The sheets of homogenised tobacco material may have an aerosol former content of between approximately 5 percent and approximately 30 percent on a dry weight basis.

[0077] In a preferred embodiment, the sheets of homogenised tobacco material have an aerosol former content of approximately 20 percent on a dry weight basis.

[0078] Sheets of homogenised tobacco material for use in the invention may comprise one or more intrinsic binders, that is tobacco endogenous binders, one or more extrinsic binders, that is tobacco exogenous binders, or a combination thereof to help agglomerate the particulate tobacco. Alternatively, or in addition, sheets of homogenised tobacco material for use in the aerosol-generating substrate may comprise other additives including, but not limited to, tobacco and non-tobacco fibres, aerosol-formers, humectants, plasticisers, flavourants, fillers, aqueous and non-aqueous solvents and combinations thereof.

[0079] Suitable extrinsic binders for inclusion in sheets of homogenised tobacco material for use in the invention are known in the art and include, but are not limited to: gums such as, for example, guar gum, xanthan gum, arabic gum and locust bean gum; cellulosic binders such as, for example, hydroxypropyl cellulose, carboxymethyl cellulose, hydroxyethyl cellulose, methyl cellulose and ethyl cellulose; polysaccharides such as, for example, starches, organic acids, such as alginic acid, conjugate base salts of organic acids, such as sodium-alginate, agar and pectins; and combinations thereof.

[0080] Suitable non-tobacco fibres for inclusion in sheets of homogenised tobacco material for use in the aerosol-generating substrate are known in the art and include, but are not limited to: cellulose fibers; soft-wood fibres; hard-wood fibres; jute fibres and combinations thereof. Prior to inclusion in sheets of homogenised tobacco material for use in the aerosol-generating substrate, non-tobacco fibres may be treated by suitable processes known in the art including, but not limited to: mechanical pulping; refining; chemical pulping; bleaching; sulfate pulping; and combinations thereof.

[0081] Sheets of homogenised tobacco for use in the invention preferably have a width of between about 70 mm and about 250 mm, for example between about 120 mm and about 160 mm. Preferably, the thickness of the sheets of homogenised tobacco material is between about 50 micrometres and about 300 micrometres, more preferably between about 150 micrometres and about 250 micrometres.

[0082] Sheets of homogenised tobacco for use in the aerosol-generating article of the present invention may be made by methods known in the art, for example the methods disclosed in International patent application WO-A-2012/164009 A2.

[0083] In a preferred embodiment, sheets of homogenised tobacco material for use in the aerosol-generating article are formed from a slurry comprising particulate tobacco, guar gum, cellulose fibres and glycerine by a casting process.

[0084] As an alternative to the use of a gathered sheet of homogenised tobacco material, as described above, the

aerosol-generating substrate may be formed of a plurality of strips or shreds of a sheet of homogenised tobacco material. For example, the aerosol-generating substrate may be formed of a plurality of shreds of homogenised tobacco material that are aligned in the longitudinal direction and have been brought together and wrapped to form a rod of aerosol-generating substrate.

[0085] The shreds of homogenised tobacco material preferably have a length of between about 10 millimetres and about 20 millimetres, more preferably between about 12 millimetres and about 18 millimetres, more preferably between about 14 millimetres and about 16 millimetres, more preferably about 15 millimetres. Alternatively or in addition, the shreds of homogenised tobacco material preferably have a width of between about 0.4 millimetres and about 0.8 millimetres.

[0086] Preferably, the density of the sheet of homogenised tobacco material from which the shreds are formed is between about 500 and about 1500 milligrams per cubic centimetre, more preferably between about 800 and about 1200 milligrams per cubic centimetre, more preferably between about 900 and about 1100 milligrams per cubic centimetre, and most preferably between about 900 and about 970 milligrams per cubic centimetre.

[0087] Preferably, the bulk density of the shreds of homogenised tobacco material within the aerosol-generating substrate is between about 0.4 grams per cubic centimetre and about 0.8 grams per cubic centimetre, preferably between about 0.5 grams per cubic centimetre and about 0.7 grams per cubic centimetre and most preferably between about 0.65 grams per cubic centimetre and about 0.67 grams per cubic centimetre.

[0088] As described above, the homogenised tobacco material may be formed by the casting of a slurry. Alternatively, the homogenised tobacco material may be formed by another suitable method, such as for example, an extrusion method.

[0089] Preferably, the aerosol-generating substrate comprises a rod of the homogenised tobacco material circumscribed by a wrapper, wherein the wrapper is provided around and in contact with the homogenised tobacco material. The wrapper may be formed from any suitable sheet material that is capable of being wrapped around homogenised tobacco material to form an aerosol-generating substrate. The wrapper may be porous or non-porous. Preferably, the wrapper is a paper wrapper but the wrapper may alternatively be non-paper.

[0090] The rod of aerosol-generating substrate preferably has an external diameter that is approximately equal to the external diameter of the aerosol-generating article.

[0091] Preferably, the rod of aerosol-generating substrate has an external diameter of at least 5 millimetres. The rod of aerosol-generating substrate may have an external diameter of between about 5 millimetres and about 12 millimetres, for example of between about 5 millimetres and about 10 millimetres or of between about 6 millimetres and about 8 millimetres. In a preferred embodiment, the rod of aerosol-generating substrate has an external diameter of 7.2 millimetres, to within 10 percent.

[0092] The rod of aerosol-generating substrate may have a length of between about 7 millimetres and about 15 mm. In one embodiment, the rod of aerosol-generating substrate may have a length of about 10 millimetres. In a preferred embodiment, the rod of aerosol-generating substrate has a length of about 12 millimetres.

[0093] Preferably, the rod of aerosol-generating substrate has a substantially uniform cross-section along the length of the rod. Particularly preferably, the rod of aerosol-generating substrate has a substantially circular cross-section.

[0094] The aerosol-generating articles according to the invention preferably comprise one or more elements in addition to the rod of aerosol-generating substrate and the thermal indicator. For example, aerosol-generating articles according to the invention may further comprise at least one of: a mouthpiece, an aerosol-cooling element and a support element such as a hollow acetate tube. For example, in one preferred embodiment, an aerosol-generating article comprises, in linear sequential arrangement, a rod of aerosol-generating substrate as described above, a support element located immediately downstream of the aerosol-generating substrate, an aerosol-cooling element located downstream of the support element, and an outer wrapper circumscribing the rod, the support element and the aerosol-cooling element. The thermal indicator may be provided at a defined location around the rod of aerosol-generating substrate and/or any other location around the article, as described above.

[0095] Aerosol-generating systems according to the present invention comprise an aerosol-generating article as described in detail above in combination with an aerosol-generating device which is adapted to receive the upstream end of the aerosol-generating article during smoking. The aerosol-generating device comprises a heating element which is configured to heat the aerosol-generating substrate in order to generate an aerosol during use. Preferably, the heating element is adapted to penetrate the aerosol-generating substrate when the aerosol-generating article is inserted into the aerosol-generating device. For example, the heating element is preferably in the form of a heater blade.

[0096] The heating element is controlled during use to operate with a defined operating temperature range, below a maximum operating temperature. The thermal indicator of the aerosol-generating article is adapted such that the threshold temperature will not be reached during normal use of the aerosol-generating article in the aerosol-generating device with the heating element operating below the maximum operating temperature. This ensures that when the aerosol-generating article and aerosol-generating device are used together, the thermal indicator will not be activated during normal use.

[0097] Preferably, the aerosol-generating device additionally comprises a housing, an electrical power supply connected to the heating element and a control element configured to control the supply of power from the power supply to the heating element.

[0098] Suitable aerosol-generating devices for use in the aerosol-generating system of the present invention are described in WO-A-2013/098405.

[0099] The invention will now be further described with reference to the figures in which:

[0100] FIG. **1** shows a perspective view of an aerosol-generating article according to the present invention;

[0101] FIG. **2** shows a perspective view of an aerosol-generating article having an 'activated' thermal indicator according to a first embodiment of the invention;

[0102] FIG. **3** shows a perspective view of an aerosol-generating article having an 'activated' thermal indicator according to a second embodiment of the invention;

[0103] FIG. **4** shows a perspective view of an aerosol-generating article having an 'activated' thermal indicator according to a third embodiment of the invention;

[0104] FIGS. **5***a* and **5***b* show a schematic cross-sectional view of an aerosol-generating system comprising an aerosol-generating device and an aerosol generating article according to the invention;

[0105] The aerosol-generating article **10** shown in the figures comprises four elements arranged in coaxial alignment: a rod of aerosol-generating substrate **20**, a support element **30**, an aerosol-cooling element **40**, and a mouthpiece **50** (shown in FIGS. **5***a* and **5***b*). Each of the four elements is circumscribed by a corresponding plug wrap (not shown). These four elements are arranged sequentially and are circumscribed by an outer wrapper **60** to form the aerosol-generating article **10**. The aerosol-generating **10** has a proximal or mouth end **70**, which a user inserts into his or her mouth during use, and a distal end **80** located at the opposite end of the aerosol-generating article **10** to the mouth end **70**.

[0106] In use air is drawn through the aerosol-generating article by a user from the distal end **80** to the mouth end **70**. The distal end **80** of the aerosol-generating article may also be described as the upstream end of the aerosol-generating article **10** and the mouth end **70** of the aerosol-generating article **10** may also be described as the downstream end of the aerosol-generating article **10**. Elements of the aerosol-generating article **10** located between the mouth end **70** and the distal end **80** can be described as being upstream of the mouth end **70** or, alternatively, downstream of the distal end **80**.

[0107] The support element **30** is in place to prevent the aerosol-generating substrate **20** from being forced downstream within the aerosol-generating article **10** towards the aerosol-cooling element **40** when a heating element of an aerosol-generating device is inserted into the aerosol-generating substrate **20**. The support element **30** also acts as a spacer to space the aerosol-cooling element **40** of the aerosol-generating article **10** from the aerosol-generating substrate **20**.

[0108] The aerosol-cooling element **40** is located immediately downstream of the support element **30**. In use, volatile substances released from the aerosol-generating substrate **20** pass along the aerosol-cooling element **40** towards the mouth end **70** of the aerosol-generating article **10**. The volatile substances may cool within the aerosol-cooling element **40** to form an aerosol that is inhaled by the user. The aerosol-cooling element comprises a crimped and gathered sheet of polylactic acid circumscribed by a wrapper **60**. The crimped and gathered sheet of polylactic acid defines a plurality of longitudinal channels that extend along the length of the aerosol-cooling element **40**.

[0109] The mouthpiece **50** is located immediately downstream of the aerosol-cooling element **40** and abuts the aerosol-cooling element **40**. The mouthpiece **50** comprises a conventional cellulose acetate tow filter of low filtration efficiency.

[0110] To assemble the aerosol-generating article **10**, the four elements described above are aligned and tightly wrapped within the outer wrapper **60**. In the embodiments illustrated in the figures, the outer wrapper **60** comprises conventional cigarette paper. A distal end portion of the outer wrapper **60** of the aerosol-generating article **10** is circumscribed by a band of tipping paper (not shown).

[0111] The aerosol-generating substrate **20** is located at the extreme distal or upstream end of the aerosol-generating article **10**. As illustrated in FIGS. **5***a* and **5***b*, the aerosol-generating substrate **20** comprises a gathered sheet of crimped homogenised tobacco material circumscribed by a wrapper. The crimped sheet of homogenised tobacco material comprises glycerin as an aerosol former.

[0112] A thermal indicator **100** is provided at a location on the outer surface of the outer wrapper **60**. The thermal indicator **100** comprises thermochromic material which is configured to undergo a visual change when the temperature at the thermal indicator **100** is above a threshold temperature.

[0113] FIG. **1** shows the outer wrapper **60** of the aerosol-generating article prior to activation of the thermal indicator **100**. In the following embodiments described herein, the thermal indicator **100** is not visible until it 'activates' or starts to undergo visual change when the temperature is above the threshold temperature.

[0114] FIG. **2** shows the article **10** after the activation of a thermal indicator **101**, according to a first embodiment, when the temperature at the thermal indicator **101** is above a threshold temperature of the thermochromic material. In this first embodiment, the thermal indicator is located around the rod of aerosol-generating substrate **20** and the threshold temperature is, at least, about 175° C. In the first embodiment of the article **10**, the thermal indicator **101** extends longitudinally along the entire length of the rod of aerosol-generating substrate **20**. However, in other arrangements in accordance to the first embodiment, the thermal indicator **101** may extend partially longitudinally along the rod of aerosol-generating substrate. For example, the thermal indicator **101** may extend at least 50% of the total length of the rod of aerosol-generating substrate **20**.

[0115] FIG. **3** shows the article **10** after the activation of a thermal indicator **102**, according to a second embodiment, when the temperature at the thermal indicator **102** is above a threshold temperature. In this second embodiment, the thermal indicator is located partially around the rod of aerosol-generating substrate **20** or the thermal indicator **102** does not totally circumscribe the outer surface of the aerosol-generating article. The threshold temperature of the thermal indicator **102** is, at least, about 175° C. However, the threshold temperature for thermal indicator **102** according to the second embodiment may likely be higher than the threshold temperature of the thermal indicator **101** according to the first embodiment.

[0116] FIG. **4** shows the article **10** after the activation of the thermal indicator **103**, according to a third embodiment, when the temperature at the thermal indicator **103** is above a threshold temperature. In this third embodiment, the thermal indicator **103** is located around the article **10** at a position downstream of the rod of aerosol-generating substrate, away from the distal end **80** of the article **10**. The thermal indicator **103** may partially circumscribe the outer surface of the aerosol-generating article and may also circumscribe a portion of the rod of aerosol-generating substrate. The threshold temperature of the thermal indicator **103** is, at least, about 115° C. The threshold temperature of the third embodiment may be lower than that of the first and second embodiments due to the relative distance of the thermal indicator **103** from the aerosol-generating substrate **20**.

[0117] As described in detail above, the visual change of the thermal indicator is configured to inform a user of the article **10** that the aerosol-generating substrate **20** of the article **10** has been overheated either because the article **10** has been misused with an incompatible aerosol-generating device or because the article has been used with an aerosol-generating device which may be malfunctioning in a manner that it is overheating the aerosol-generating substrate **20**. Consequently, in order to convey such information of misuse of the article **10**, the visual change of the thermal indicators **101**, **102**, **103** are preferably irreversible such that the visual change, upon removal of the article **10** from an aerosol-generating device, does not 'disappear' and remains visible to the user when the substrate **20** has cooled. As shown in FIGS. **2**, **3** and **4**; the irreversible visual change comprises a colour change from colourless to red and the appearance of warning messages or graphical representations.

[0118] The aerosol-generating articles illustrated in the above described figures are designed to engage with an aerosol-generating device comprising a heating element in order to be consumed by a user. In use, the heating element of the aerosol-generating device heats the aerosol-generating substrate of the aerosol-generating article to a sufficient temperature to form an aerosol, which is drawn downstream through the aerosol-generating article and inhaled by the user.

[0119] FIGS. **5***a* and **5***b* illustrate an aerosol-generating system **500** comprising an aerosol-generating device **510** and an aerosol-generating article **10** according to any of the embodiments described above and shown in the figures described above. It will be appreciated that the aerosol-generating device **510** could be used in combination with an alternative aerosol-generating article according to the invention.

[0120] The aerosol-generating device **510** comprises a heating element **520**. As shown in FIGS. **5***a* and **5***b*, the heating element **520** is mounted within an aerosol-generating article receiving chamber **515** of the aerosol-generating device **510**. In use, the user inserts the aerosol-generating article **10** into the aerosol-generating article receiving chamber **515** of the aerosol-generating device **510** such that the heating element **520** is directly inserted into the aerosol-generating substrate **20** of the aerosol-generating article **10** as shown in FIG. **5***b*. In the embodiment shown in FIGS. **5***a* and **5***b*, the heating element **520** of the aerosol-generating device **510** is a heater blade.

[0121] The aerosol-generating device **510** comprises a power supply and electronics (not shown) that allow the heating element **520** to be actuated. Such actuation may be manually operated or may occur automatically in response to a user drawing on an aerosol-generating article **10** inserted into the aerosol-generating article receiving chamber of the aerosol-generating device **510**. A plurality of openings (not shown) may be provided in the aerosol-generating device **510** to allow air to flow to the aerosol-generating article **10**.

[0122] Once the internal heating element **520** is inserted into the aerosol-generating substrate **20** of the aerosol-generating article **10** and the heating element **520** is actuated, the aerosol-generating substrate **20** of the aerosol-generating article **10** is heated to a temperature of approximately 350° C. by the heating element **520** of the aerosol-generating device **510**. At this temperature, volatile compounds are evolved from the aerosol-generating substrate **20** of the aerosol-generating article **10**. As a user draws on the mouth end **70** of the aerosol-generating article **10**, the volatile compounds evolved from the aerosol-generating substrate **20** are drawn downstream through the aerosol-generating article **10** and condense to form an aerosol that is drawn through the mouthpiece **50** of the aerosol-generating article **10** into the user's mouth.

[0123] As the aerosol passes downstream thorough the aerosol-cooling element **40**, the temperature of the aerosol is reduced due to transfer of thermal energy from the aerosol to the aerosol-cooling element **40**. When the aerosol enters the aerosol-cooling element **40**, its temperature is approximately 60° C. Due to cooling within the aerosol-cooling element **40**, the temperature of the aerosol as it exits the aerosol-cooling element is approximately 40° C.

[0124] In FIGS. **5***a* and **5***b*, the heating element **520** of the aerosol-generating device **510** is shown in a simplified manner. Particularly, the heating element **520** of the aerosol-generating device **510** is not drawn to scale in FIGS. **5***a* and **5***b*. Components that are not relevant for the understanding of the embodiment have been omitted to simplify FIGS. **5***a* and **5***b*.

[0125] As shown in FIGS. **5***a* and **5***b*, the aerosol-generating device **510** comprises a housing **530**. The heating element **520** is mounted within an aerosol-generating article receiving chamber within the housing **530**. The aerosol-generating article **10** is inserted into the aerosol-generating article receiving chamber **515** within the housing **530** of the aerosol-generating device **510** such that the heating element **520** is directly inserted into the aerosol-generating substrate **20** of the aerosol-generating article **10**.

[0126] Within the housing **530** there is an electrical energy supply (not shown), for example a rechargeable lithium ion battery. A controller (not shown) is connected to the heating element **520**, the electrical energy supply, and a user interface (not shown), for example a button or display. The controller of the aerosol-generating device controls the power supplied to the heating element **520** in order to regulate its temperature.

[0127] During this normal usage of the aerosol-generating articles according to the invention with the compatible aerosol-generating device **510** shown in FIGS. **5***a* and **5***b*, the thermal indicator of the aerosol-generating article remains 'inactivated' due to the use of the article with a compatible aerosol-generating device and, as such, overheating does not occur in the aerosol-generating substrate.

[0128] In the event that the aerosol-generating articles according to the invention are used with an incompatible device and are overheated to above a preferred maximum operating temperature, the thermal indicator will 'activate', that is undergo a visual change, upon reaching the predetermined threshold temperature of the thermal indicator. Upon removal of the article from the aerosol-generating device, the user will be informed of the misuse of the article when she sees the 'activated' thermal indicator of the articles.

[0129] As such, the incorporation of the thermal indicator into the aerosol-generating articles of the present invention provides an effective means of protecting the consumer from use of the aerosol-generating article in an unintended manner in an incompatible device and/or from use of the article in a defective or malfunctioning compatible device.

1.-15. (canceled)

16. An aerosol-generating article for an aerosol-generating device having a heating element, the aerosol-generating article comprising:

a rod of aerosol-generating substrate, the rod of aerosol-generating substrate being formed of an aerosol-forming material having an aerosol former content of between 5 percent and 30 percent on a dry weight basis; and

an outer wrapper, wherein the outer wrapper is wrapped around at least a portion of the rod of aerosol-generating substrate and at least a portion of an outer surface of the wrapper comprises a thermal indicator, the thermal indicator comprising:

a thermochromic material, whereby at least a portion of the thermochromic material is configured to undergo a visual change when a temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that a temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 175 degrees Celsius.

17. An aerosol-generating article for an aerosol-generating device having a heating element, the aerosol-generating article comprising:

a rod of aerosol-generating substrate; and

an outer wrapper, wherein the outer wrapper is wrapped around at least a portion of the rod of aerosol-generating substrate and at least a portion of an outer surface of the wrapper comprises a thermal indicator, the thermal indicator comprising:

a thermochromic material, whereby at least a portion of the thermochromic material is configured to undergo a visual change when a temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that a temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 175 degrees Celsius,

wherein the thermal indicator overlies at least 5 square millimetres of an external surface area of the rod of aerosol-generating substrate.

18. An aerosol-generating article for an aerosol-generating device having a heating element, the aerosol-generating article comprising:

a rod of aerosol-generating substrate; and

an outer wrapper, wherein the outer wrapper is wrapped around at least a portion of the rod of aerosol-generating substrate and at least a portion of an outer surface of the wrapper comprises a thermal indicator, the thermal indicator comprising:

a thermochromic material, whereby at least a portion of the thermochromic material is configured to undergo a visual change when a temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that a temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 220 degrees Celsius.

19. The aerosol-generating article according to claim 16, wherein the threshold temperature is at least about 220 degrees Celsius.

20. The aerosol-generating article according to claim 16, wherein the thermal indicator overlies at least 5 square millimetres of an external surface area of the rod of aerosol-generating substrate.

21. The aerosol-generating article according to claim 16, wherein the thermal indicator extends longitudinally along at least 50 percent of a total length of the rod of aerosol-generating substrate.

22. The aerosol-generating article according to claim 16,

wherein the thermochromic material is arranged such that the visual change occurs only within a circumferential portion of the outer wrapper, and

wherein the circumferential portion extends only partially around a circumference of the aerosol-generating article.

23. An aerosol-generating article for an aerosol-generating device having a heating element, the aerosol-generating article comprising:

a rod of aerosol-generating substrate, the rod of aerosol-generating substrate being formed of an aerosol-forming material having an aerosol former content of between 5 percent and 30 percent on a dry weight basis; and

an outer wrapper, wherein at least a portion of an outer surface of the wrapper comprises a thermal indicator, wherein the thermal indicator is disposed downstream of the rod of aerosol-generating substrate, the thermal indicator comprising:

a thermochromic material, whereby at least a portion of the thermochromic material is configured to undergo a visual change when a temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that a temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 115 degrees Celsius.

24. The aerosol-generating article according to claim 16, wherein the visual change is irreversible.

25. The aerosol-generating article according to claim 16, wherein the thermal indicator extends longitudinally along at least 20 percent of a total length of the aerosol-generating article.

26. The aerosol-generating article according to claim 16, wherein the visual change comprises a colour change.

27. The aerosol-generating article according to claim 16, wherein the visual change comprises displaying a graphical representation and/or warning indicia or messages.

28. The aerosol-generating article according to claim 16, wherein the outer wrapper comprises temperature indicating sensor paper, whereby the thermochromic material is integral to the temperature indicating sensor paper.

29. The aerosol-generating article according to claim 16, wherein the thermochromic material comprises thermochromic paint, ink, or dye applied to the at least a portion of the outer surface of the wrapper.

30. The aerosol-generating article according to claim 16, further comprising:

a mouthpiece disposed downstream of the rod of aerosol-generating substrate;

a support element disposed immediately downstream of the rod of aerosol-generating substrate; and

an aerosol-cooling element disposed between the support element and the mouthpiece.

31. A thermochromic material in a thermal indicator disposed on an outer wrapper of a rod of aerosol-generating substrate of an aerosol-generating article, the rod of aerosol-generating substrate being formed of an aerosol-forming material having an aerosol former content of between 5 percent and 30 percent on a dry weight basis and the aerosol-generating article being configured to be used with an aerosol-generating device having a heating element, wherein the outer wrapper is wrapped around at least a portion of the rod of aerosol-generating substrate and whereby at least a portion of the thermochromic material is configured to undergo a visual change when a temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that a temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 175 degrees Celsius.

32. A thermochromic material in a thermal indicator disposed on an outer wrapper of an aerosol-generating article, the aerosol-generating article being configured to be used with an aerosol-generating device having a heating element, and the aerosol-generating article comprising a rod of aerosol-generating substrate, the rod of aerosol-generating substrate being formed of an aerosol-forming material having an aerosol former content of between 5 percent and 30 percent on a dry weight basis, whereby the thermal indicator is disposed downstream of the rod of aerosol-generating substrate and at least a portion of the thermochromic material is configured to undergo a visual change when a temperature at said portion of the thermochromic material exceeds a threshold temperature, such that the outer wrapper provides a visual indication that a temperature at the thermal indicator has exceeded the threshold temperature, wherein the threshold temperature is at least about 115 degrees Celsius.

33. An aerosol-generating system, comprising:

an aerosol-generating article according to claim **16**; and

an aerosol-generating device configured to receive the aerosol-generating article, the aerosol-generating device comprising a heater element configured to heat a rod of aerosol-generating material,

wherein the heater element is configured so as to be controlled to operate below a maximum operating temperature,

wherein a thermal indicator of the aerosol-generating article is configured such that a threshold temperature is not exceeded during use of the aerosol-generating system with the heater element operating below the maximum operating temperature.

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