Title: AEROSOL-GENERATING ARTICLE HAVING ROD WITH AEROSOL-GENERATING SUBSTRATE GRIPPING MEANS

Abstract: The present invention provides a rod (12) of aerosol-generating substrate for use in an aerosol-generating article (10), the rod comprising an aerosol-generating element (30) extending in the longitudinal direction and comprising one or more sheets of homogenised tobacco material. The rod (12) further comprises a wrapper (32) circumscribing the aerosol-generating element (30); and at least one gripping band (34) for gripping the aerosol-generating element (30), the at least one gripping band (34) circumscribing the rod (12) of aerosol-generating substrate at a location along the length of the rod (12).
AEROSOL-GENERATING ARTICLE HAVING ROD WITH AEROSOL-GENERATING SUBSTRATE GRIPPING MEANS

The present invention relates to an aerosol-generating article comprising an aerosol-generating substrate.

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.

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.

Substrates for heated aerosol-generating articles have, in the past, typically been produced using randomly oriented shreds, strands, or strips of tobacco material. The formation of rods for heated smoking or aerosol-generating articles from shreds of tobacco material suffers from a number of disadvantages. For example, the process of shredding tobacco material undesirably generates tobacco fines and other waste. Rods comprising shreds of tobacco material may exhibit “loose ends”, that is, a loss of shreds of tobacco material from the ends of the rods. Rods comprising shreds of tobacco material may exhibit high standard deviations in weight, partially due to the tendency of rods to exhibit loose ends. Also, rods comprising shreds of tobacco material tend to exhibit non-uniform densities, that is, the density along the length of the rod tends to be inconsistent due to variations in the quantity of tobacco material at different locations along the rod. Furthermore, loose ends may disadvantageously lead to the need for more frequent cleaning of an aerosol-generating device for use with the aerosol-generating article and of manufacturing equipment.

By way of example, international patent application WO-A-20 12/1 64009 discloses rods for heated aerosol-generating articles formed from gathered sheets of tobacco material. The rods disclosed in WO-A-20 12/1 64009 have a longitudinal porosity that allows air to be drawn through the rods. Effectively, folds in the gathered sheets of tobacco material define longitudinal channels through the rod. The use of rods formed from gathered sheets of homogenised tobacco material addresses some of the problems associated with forming an aerosol-generating substrate from
shredded tobacco. However, such sheets typically have a relatively low tensile strength and so
the gathering of the sheets to form the rods can have drawbacks.

International patent application WO-A-201 1/101 164 discloses alternative rods for heated
aerosol-generating articles formed from strands of homogenised tobacco material, which may be
formed by casting, rolling, calendering or extruding a mixture comprising particulate tobacco and
at least one aerosol former to form a sheet of homogenised tobacco material. In an alternative
embodiments, the rods of WO-A-201 1/101 164 may be formed from strands of homogenised
tobacco material obtained by extruding a mixture comprising particulate tobacco and at least one
aerosol former to form continuous lengths of homogenised tobacco material.

However, achieving consistent and accurate control of the amount of tobacco substrate in
rods of the type described above can be difficult, particularly when operating at high speed.
Further, depending on the shape and arrangement of sheets or strands of homogenised tobacco,
it may be particularly difficult to control the porosity and resistance to draw (RTD) of the aerosol-
generating article.

In addition, whilst they address some of the issues associated with forming an aerosol-
generating substrate from shredded tobacco, rods formed from gathered sheets of homogenised
tobacco material can have drawbacks because such sheets typically have a relatively low tensile
strength. As a consequence, rods formed from gathered sheets of homogenised tobacco material
can break along folds in the sheet, especially when heated, such that smaller longitudinal strip
sections of homogenised tobacco material may detach from the remainder of the rod and be
dislodged when an insertable heater element is extracted from the rod after use.

Thus, it would be desirable to provide an alternative aerosol-generating article that is
adapted to prevent particles or fragments of the aerosol-generating substrate from becoming
dislodged from the rod. At the same time, it would be desirable to provide a rod for use in one
such aerosol-generating article that facilitates insertion of the heater element into the substrate
during use. It would be equally desirable to provide one such substrate or rod that can be
manufactured efficiently and at high speed, as well as to provide a method of manufacturing such
a rod.

According to an aspect of the present invention, there is provided an aerosol-generating
article for producing an inhalable aerosol when heated. The aerosol-generating article comprises
a rod of aerosol-generating substrate having a length, wherein the rod of aerosol-generating
substrate comprises an aerosol-generating element extending in the longitudinal direction and
comprising one or more sheets of aerosol-generating material. Further, the rod comprises a
wrapper circumscribing the aerosol-generating element. In addition, the rod comprises at least
one gripping band for gripping the one or more aerosol-generating element, the at least one
gripping band circumscribing the rod of aerosol-generating substrate at a location along the length
of the rod.
According to another aspect of the present invention, there is provided a rod of aerosol-generating substrate for use in an aerosol-generating article, the rod comprising an aerosol-generating element extending in the longitudinal direction and comprising one or more sheets of aerosol-generating material. Further, the rod comprises a wrapper circumscribing the aerosol-generating element. In addition, the rod comprises at least one gripping band for gripping the aerosol-generating element, the at least one gripping band circumscribing the rod of aerosol-generating substrate at a location along the length of the rod.

According to a further aspect of the present invention, there is provided a method of making a rod of aerosol-generating substrate for use in an aerosol-generating article, the method comprising the steps of: providing an aerosol-generating element comprising one or more sheets of aerosol-generating material; assembling the aerosol-generating element such that the element extends in a longitudinal direction; circumscribing the assembled element with a wrapper to form a continuous rod; providing one or more gripping bands for gripping the aerosol-generating element, the one or more gripping bands circumscribing the continuous rod at distinct locations along the length of the continuous rod; severing the continuous rod at intermediate locations along the length of the continuous rods to provide multiple discrete rods, such that each discrete rod comprises at least one gripping band.

According to another aspect of the present invention, there is provided a method of making an aerosol-generating article, the method comprising the steps of: providing an aerosol-generating element comprising one or more sheets of aerosol-generating material; assembling the aerosol-generating element such that the element extends in a longitudinal direction; circumscribing the assembled element with a wrapper to form a continuous rod of aerosol-generating substrate; severing the continuous rod into a plurality of discrete rods of aerosol-generating substrate; providing at least one further article element in substantial longitudinal alignment with one of the discrete rods; circumscribing the discrete rod and the further article element with an outer wrapper to form an aerosol-generating article; providing a gripping band for gripping the aerosol-generating element, the band circumscribing the discrete rod of aerosol-generating substrate at a location along the length of the discrete rod.

It will be appreciated that any features described with reference to one aspect of the present invention are equally applicable to any other aspect of the invention.

The term “aerosol-generating article” is used herein to denote both articles wherein an aerosol-generating substrate is heated and articles wherein an aerosol-generating substrate is combusted, such as conventional cigarettes. As used herein, the term “aerosol-generating substrate” denotes a substrate capable of releasing volatile compounds upon heating to generate an inhalable aerosol.

In heated aerosol-generating articles, an inhalable aerosol is generated by heating a flavour generating substrate, such as tobacco, without combustion. 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 European patent application EP 0822670. 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. Alternatively, aerosol-generating article according to the invention may comprise a combustible carbon heat source for heating the aerosol-generating substrate during use. Aerosol-generating articles of this type are described in the prior art, for example, in international patent application WO 2009/022232. Also known are aerosol-generating articles in which a nicotine-containing aerosol is generated from a tobacco material, tobacco extract, or other nicotine source, without combustion, and in some cases without heating, for example through a chemical reaction. During smoking, volatile compounds are released from the aerosol forming substrate by heat transfer from the fuel element and entrained in air drawn through the aerosol-generating article. As the released compounds cool they condense to form an aerosol.

As used herein, the term “aerosol-generating element” denotes a component of the aerosol-generating substrate that is adapted to release volatile compounds upon heating to generate an aerosol. Aerosol-generating elements may have different geometries. Aerosol-generating elements for forming an aerosol-generating substrate for use in an aerosol-generating article in accordance with the present invention are generally elongate and may comprise one or more sheets of aerosol-generating material, which may be provided in different arrangements. By way of example, an aerosol-generating element in an aerosol-generating article in accordance with the present invention may comprise a single, gathered sheet of an aerosol-generating material, as well as a plurality of stacked sheets of an aerosol-generating material. As used herein, the term “stacked” refers to the arrangement of a plurality of sheets one over another. By way of example, the “stacked” sheets may be arranged one over another with spacing between adjacent sheets. However, the term “stacked” encompasses arrangements of sheets in which adjacent sheets are at least partially in contact with each other so that the sheets are spaced apart in some areas whilst in other areas the spacing between the adjacent sheets may approach zero. The term “stacked” is used herein irrespective of the orientation of the stacked sheets. For example, in the aerosol-generating element of the rod of aerosol-generating articles according to the invention, each sheet may be arranged such that the plane of the sheet extends longitudinally along the aerosol-generating article.
The aerosol-generating material these sheets formed from may be a tobacco material, such as a homogenised tobacco material, or a non-tobacco material comprising and being adapted to release at least one aerosol former. By way of example, the non-tobacco material may be adapted to adsorb the aerosol former on its surface or to absorb the aerosol former within its structure.

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 one or more of tobacco dust, tobacco fines, and other particulate tobacco by-products formed during the treating, handling and shipping of tobacco as well as binder, aerosol formers, flavours, other non-tobacco materials, like other plant material, including fibres and others. 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.

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. 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.

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 sheets in the longitudinal direction.

The term “outer diameter of the rod” is used herein to denote the outer diameter of the wrapper circumscribing the aerosol-generating substrate in a non-deformed state. As will be explained in greater detail below, at least during use the at least one gripping band applies a compressive load directed radially at a location along the length of the rod. This may cause a local deformation of the rod, such that a diameter of the rod as measured at the location where the at least one gripping band is provided is smaller than a diameter of the rod in the non-deformed state.

The term “an inner diameter of the gripping band” is used herein to denote the inner diameter of the gripping band circumscribing the wrapper of the rod. The gripping band has a “nominal inner diameter”, which is the inner diameter of the gripping band as measured prior to the aerosol-generating article being used. During use, the inner diameter of the gripping band may remain constant or decrease. By way of example, the gripping band may comprise a heat-
shrinkable material, such that the inner diameter of the gripping band decreases from the nominal value to a smaller value as the rod of aerosol-generating substrate is heated.

The at least one gripping band may be formed from a rigid or substantially non-elastically-deformable material. Alternatively, the at least one gripping band may be formed from an elastically deformable material. In this case, the nominal inner diameter of the at least one gripping band is the inner diameter of the gripping band in a non-deformed state.

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.

As briefly described above, the aerosol-generating article of the present invention incorporates a rod of aerosol-generating substrate comprising one or more aerosol-generating elements extending in the longitudinal direction. The aerosol-generating element comprises one or more sheets of aerosol-generating material. Further, the rod comprises a wrapper circumscribing the one or more aerosol-generating elements and at least one gripping band for gripping the one or more aerosol-generating elements, the at least one gripping band circumscribing the rod of aerosol-generating substrate at a location along the length of the rod.

By applying a compressive load directed radially on the aerosol-generating element or elements in the rod, during use the at least one gripping band reduces the likelihood that particles or fragments of aerosol-generating substrate, which may become detached from the remainder of the aerosol-generating substrate, are pulled out of the rod upon extracting the heater element from the rod. In addition, depending on the positioning of the gripping band, by holding the sheet or sheets of aerosol-generating material in a tight arrangement, it may advantageously be possible to produce an increase in the RTD of the aerosol-generating article.

Further, without wishing to be bound by theory, it is understood that, because the sheet or sheets of aerosol-generating material are held in a tight arrangement during use, the transfer of heat from the heater element may be more efficient, such that the heating of the most peripheral regions of aerosol-generating substrate in the rod is improved.

In some embodiments, the at least one gripping band is adapted to apply the radial compressive load only after use of the aerosol-generating article is initiated - for example, upon exposure to heat. This facilitates the insertion of a heater element, like a heater blade, into the rod, since the one or more sheets of aerosol-generating material become held tightly together only after the heater blade is in place within the aerosol-generating substrate.

Rods of aerosol-generating substrate in accordance with the invention can be made in a continuous process which can be efficiently carried out at high speed, and can be conveniently incorporated into existing production lines for the manufacture of aerosol-generating articles.
In aerosol-generating articles in accordance with the invention, the rod of aerosol-generating substrate preferably has an external diameter that is approximately equal to the external diameter of the aerosol-generating article.

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.

The rod of aerosol-generating substrate may have a length of between about 5 millimetres and about 100 mm. Preferably, the rod of aerosol-generating substrate has a length of at least about 5 millimetres, more preferably at least about 7 millimetres. In addition, or as an alternative, the rod of aerosol-generating substrate preferably has a length of less than about 25 millimetres, more preferably less than about 20 millimetres. 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.

As used herein, the term 'rod' is used to denote a generally cylindrical element of substantially circular, oval or elliptical cross-sectional shape. Preferably, the rod of aerosol-generating substrate has a substantially uniform cross-sectional shape along the length of the rod. Particularly preferably, the rod of aerosol-generating substrate has a substantially circular cross-sectional shape.

Aerosol-generating articles in accordance with the present invention comprise one or more elements of an aerosol-generating substrate. The one or more elements of aerosol-generating substrate may be provided in different forms and geometries.

In some embodiments, the element of aerosol-generating substrate may be provided as a gathered sheet of homogenised tobacco material, which is preferably crimped. The term "gathered" denotes that the sheet of homogenised tobacco material is convoluted, folded, or otherwise compressed or constricted substantially transversely to the longitudinal axis of the rod. The gathered sheet of homogenised tobacco material preferably has a length of at least 50 percent of the overall length of the rod of aerosol-generating substrate, and even more preferably extends along substantially the entire length of the rod and across substantially the entire transverse cross-sectional area of the rod. The term "crimped sheet" is intended to be synonymous with the term "creped sheet" and denotes a sheet having a plurality of substantially parallel ridges or corrugations. Preferably, the crimped sheet of homogenised tobacco material has a plurality of ridges or corrugations substantially parallel to the longitudinal axis of the rod. This advantageously facilitates gathering of the crimped sheet of homogenised tobacco material to form the rod. However, it will be appreciated that crimped sheets of homogenised tobacco
material for use in the invention 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 rod.

In preferred embodiments, the element of aerosol-generating substrate is formed of a porous tobacco material, such that air flow through a surface of the elements of aerosol-generating substrate - that is, airflow along a substantially radial direction in the rod - is possible. As used herein with reference to an aerosol-generating material, and particularly with reference to homogenised tobacco material, the term “porous” may indicate that the aerosol-generating material (tobacco material) has been produced within an inherent porosity so that sufficient pores or interstices are provided within the structure of a sheet such as to enable the flow of air through the sheet or web in a direction transverse to a surface of the sheet or web. Alternatively or in addition, the term “porous” may indicate that each sheet of aerosol-generating material (tobacco material) comprises a plurality of air flow holes to provide the desired porosity. For example, a sheet of tobacco material may be punctured with a pattern of air flow holes prior to undergoing the rolling operation that produces the elongate tubular elements of the rod of aerosol-generating substrate. The airflow holes may be punctured randomly or uniformly over the sheet. The pattern of air flow holes may cover substantially the full surface of the sheet, or may cover one or more specific areas of the sheet, with the remaining areas being free from air flow holes.

Preferably, the sheet of aerosol-generating material, such as homogenised tobacco material, from which an element of aerosol-generating substrate is formed is textured. As used herein the term “textured” refers to a sheet or web that has been crimped, embossed, debossed, perforated or otherwise locally deformed. For example, the sheet or web may comprise a plurality of spaced-apart indentations, protrusions, perforations or a combination thereof. Texture may be provided on one side of each sheet, or on both sides of each sheet.

Alternatively or in addition to the provision of texture on the surface of at least one of the one or more sheets of aerosol-generating material, an additive may be applied to at least a part of a surface of sheets. The additive may be a solid additive, a liquid additive, or a combination of a solid additive and a liquid additive. Suitable solid and liquid additives for use in the invention are known in the art and include, but are not limited to: flavourants, such as for example menthol; adsorbents, such as for example activated carbon; fillers, such as for example calcium carbonate; and botanical additives.

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 60 percent by weight on a dry weight basis, more preferably or at least about 70 percent by weight on a dry basis and most preferably at least about 90 percent by weight on a dry weight basis.
Sheets of homogenised tobacco material for use in the aerosol-generating substrate 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.

Suitable extrinsic binders 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: 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.

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.

Preferably, the sheets of homogenised tobacco material comprise an aerosol former. As used herein, the term “aerosol former” describes any suitable known compound or mixture of compounds that, in use, facilitates formation of an aerosol and that is substantially resistant to thermal degradation at the operating temperature of the aerosol-generating article.

Suitable aerosol-formers are known in the art and include, but are not limited to: polyhydric alcohols, such as propylene glycol, 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 and dimethyl tetradecanedioate.

Preferred aerosol formers are polyhydric alcohols or mixtures thereof, such as propylene glycol, triethylene glycol, 1,3-butanediol and, most preferred, glycerine.

The sheets of homogenised tobacco material may comprise a single aerosol former. Alternatively, the sheets or webs of homogenised tobacco material may comprise a combination of two or more aerosol formers.

Preferably, the sheets of homogenised tobacco material have an aerosol former content of greater than 5 percent on a dry weight basis. 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. In a preferred embodiment, the sheets of homogenised tobacco material have an aerosol former content of approximately 20 percent on a dry weight basis.

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. 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.

Preferably, each sheet of aerosol-generating material has a length substantially equal to the length of the rod of aerosol-generating substrate. In one embodiment, each sheet has a length of between about 5 millimetres and about 80 millimetres. In a preferred embodiment, each sheet has a length of between about 7 millimetres and about 40 and most preferably, each sheet has a length of between about 8 millimetres and about 28 millimetres.

As described above, the one or more elements of aerosol-generating substrate forming the rod of aerosol-generating substrate are circumscribed by a wrapper. The wrapper may be formed of a porous or non-porous sheet material. The wrapper may be formed of any suitable material or combination of materials. Preferably, the wrapper is a paper wrapper. The wrapper may optionally be adhered to the outer edges of the one or more elements. For example, at least one of the inner surface of the wrapper and the outer edges of the one or more elements may be wetted during the production process such that the inner wrapper adheres to the edges of the one or more elements during the wrapping process. Alternatively, an adhesive may be applied to at least one of the inner surface of the wrapper and the outer edges of the one or more elements upstream of the wrapping step. The adhesion of the one or more sheets and the wrapper may advantageously help to retain the position and spacing of the one or more sheets within the rod.

The wrapper may optionally be at least partially folded over the one or more sheets at the upstream and downstream ends of the rod to retain the one or more sheets within the rod. Preferably, the wrapper overlies the periphery of the one or more sheets at the upstream and downstream ends of the rod so that the remainder of the one or more sheets is exposed. However, in some embodiments, the wrapper may overlie the entire upstream and downstream ends of the rod. In such embodiments, air flow may advantageously be made possible by providing a wrapper having a sufficient porosity to enable air flow through the ends of the rod.

As an alternative to folding the ends of the wrapper over the upstream and downstream ends of the one or more sheets, a separate rim section of paper or other material may be attached to the wrapper to overlie at least the periphery of the upstream and downstream ends of the one or more sheets, as described above. In such embodiments, where the wrapper is folded over the ends of the rod, or where a separate rim section is provided, an additional outer wrapper may be provided overlying the wrapper that circumscribes the one or more sheets.
The rod of aerosol-generating substrate has a distal end and a proximal end opposite the distal end. Preferably, the at least one gripping band circumscribes the rod of aerosol-generating substrate at a location along the length of the rod such that a centre of the gripping band is spaced from both the distal end and the proximal end by at least 25 percent of the length of the rod, that is, a quarter of the length of the rod. More preferably, a centre of the gripping band is spaced from both the distal end and the proximal end by at least 33 percent of the length of the rod, that is, substantially a third of length of the rod. Even more preferably, a centre of the gripping band is spaced from both the distal end and the proximal end by at least 45 percent of the length of the rod. In particularly preferred embodiments, a centre of the gripping band is spaced from both the distal end and the proximal end by about 50 percent of the length of the rod.

Without wishing to be bound by theory, it is understood that this is advantageous in that, by providing the gripping band at a location substantially centred relative to the length of the rod, the gripping band applies on the sheet or sheets of aerosol-generating material a compressive load distributed substantially symmetrically, which facilitates holding the sheet or sheets into place prior to and during use of the aerosol-generating article. Such positioning of the gripping band is especially advantageous where the rod of aerosol-generating substrate, and consequently the article as a whole, are “short”. This applies, by way of example, to embodiments wherein the rod has a length of less than about 40 millimetres, preferably less than 25 millimetres, even more preferably less than 20 millimetres.

Further, such positioning of the gripping band is particularly advantageous where the sheet or sheets of aerosol-generating material, such as sheets of homogenised tobacco, have a length of at least about 50 percent of the entire length of the rod, and even more so where they substantially extend all the way from the distal end to the proximal end of the rod.

Preferably, at least during use an inner diameter of the at least one gripping band is smaller than an outer diameter of the rod of aerosol-generating substrate. In other words, during use an inner diameter of the at least gripping band is less than 100 percent of an outer diameter of the rod. By adjusting the inner diameter of the at least one gripping band during use it is advantageously possible to tune the compressive load applied by the at least one gripping band over the rod and, in particular, over the elements of aerosol-generating substrate. In general, smaller inner diameters correspond to a tighter packing of the elements of aerosol-generating substrate and may lead to greater increases in the RTD of the aerosol-generating article.

More preferably, at least during use, the inner diameter of the at least one gripping band is less than about 95 percent of the outer diameter of the rod of aerosol-generating substrate. Even more preferably, at least during use the inner diameter of the at least one gripping band is less than about 90 percent of the outer diameter of the rod of aerosol-generating substrate. With gripping bands having an inner diameter during use of less than about 95 percent of the outer diameter of the rod of aerosol-generating substrate, the likelihood that particles or fragments of
aerosol-generating substrate may be pulled out of the rod upon extracting the heater element from the rod is significantly reduced and particularly satisfactory RTD values are provided.

In some embodiments the at least one gripping band may comprise an elastic material and a nominal inner diameter of the gripping band is smaller than an outer diameter of the rod of aerosol-generating substrate. Suitable elastic materials will be known to the skilled person and comprise elastomers having heat resistance to temperatures in the operative range of the aerosol-generating article. By way of example, silicone compounds, or elastomeric compounds such as ethylene acrylic elastomers and fluoroelastomers may be used.

In these embodiments, the gripping band can be stretched to an increased diameter for fitting around the wrapper of the rod of aerosol-generating substrate. Once fitted around the rod of aerosol-generating substrate, the inner diameter of gripping band remains substantially the same, that is, substantially equal to the nominal inner diameter at any time prior to, during and after use, unless it is not brought into a deformed state again.

In these embodiments, the gripping band may have a thickness, measured in the radial direction, of between 0.5 and 2 millimetres, or optionally, between 0.75 and 1.25 millimetres.

In alternative embodiments, the gripping band may comprise a non-elastic material, such as a substantially rigid polymeric material or paper.

In other embodiments the at least one gripping band comprises a heat-shrinkable material. By way of example, the gripping band may comprise cellulose derived materials such as cellophane®, polyvinyl chloride or a polyolefin such as polypropylene. As an alternative, the gripping band may be entirely formed from a heat-shrinkable material. In these embodiments, a nominal diameter of the gripping band is preferably substantially identical to or greater than an outer diameter of the rod of aerosol-generating substrate. Thus, it is easy to fit the gripping band over the rod of aerosol-generating substrate, and because the gripping band does not apply a significant radial compressive load onto the elements of aerosol-generating substrate prior to use it is also easy to insert a heater element into the rod. When, during use, heat is applied to the rod for releasing the aerosol, the inner diameter of the gripping band is reduced from the nominal diameter to a value less than the outer diameter of the rod of aerosol-generating substrate, such that the gripping band exerts an increased radial compressive load onto the elements of aerosol-generating substrate. Accordingly, during and after use, the elements of aerosol-generating substrate are held in a tight arrangement, and the likelihood of fragments of aerosol-generating substrate becoming dislodged or being removed when the heater element is extracted from the rod is advantageously reduced.

In these embodiments, the at least one gripping band may have a thickness, measured in the radial direction, of between 5 and 100 micrometres, or optionally, between 10 and 20 micrometres.
In embodiments, the at least one gripping band may have a width, measured in the longitudinal direction, of between 1 and 10 millimetres, or optionally, between 2 and 6 millimetres.

However, it will be appreciated that heat may be selectively applied to a gripping band having a nominal diameter substantially identical to or greater than an outer diameter of the rod of aerosol-generating substrate prior to the aerosol-generating article being used, for example, during the manufacturing process, such that the gripping band is shrunk to a diameter smaller than the outer diameter of the rod prior to use of the aerosol-generating article.

In some embodiments, the aerosol-generating article comprises at least one further article element in substantial longitudinal alignment with the rod of aerosol-generating substrate and an outer wrapper circumscribing the rod and the further article element, wherein the at least one gripping band circumscribes the outer wrapper.

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 at least one gripping band may generally be provided at an intermediate location along the length of the rod between an upstream end and a downstream end of the rod of aerosol-generating substrate. By way of example, the at least one gripping band may be provided at a location along the length of the rod which is substantially equally distant from both the upstream end and the downstream end of the rod.

In those embodiments where the aerosol-generating article comprises at least a further article element downstream of the rod of aerosol-generating article as described above, the gripping band may be closer to the downstream end (proximal end) of the rod than to the upstream end (distal end) of the rod. This means that the gripping band is closer to the additional downstream element than to the upstream end of the rod. This may be advantageous in that, when a heater element is inserted into the rod from the upstream end, a distal tip of the heater element generally extends through the aerosol-generating substrate.

A rod for use in an aerosol-generating article as described above may be manufactured by a method as set out below. In a first step of the method, there are provided one or more aerosol-generating elements comprising one or more sheets of aerosol-generating material. In a second step, the one or more aerosol-generating elements are assembled such that the elements extend in a longitudinal direction. In a third step, the assembled elements are circumscribed with a wrapper to form a continuous rod. In a fourth step, gripping bands are provided for gripping the
one or more aerosol-generating elements, the one or more gripping bands circumscribing the continuous rod at distinct locations along the length of the continuous rod. In a fifth step, the continuous rod is severed at intermediate locations along the length of the continuous rods to provide multiple discrete rods, such that each discrete rod comprises at least a gripping band.

Preferably, the one or more gripping bands are provided such that a centre of the at least one gripping band being spaced from both a distal end and a proximal end of the discrete rod by at least 25 percent of the length of the discrete rod.

In some embodiments, the method may further comprise a sixth step of applying heat to the gripping band prior to the rod being used in an aerosol-generating article.

An aerosol-generating article in accordance with the invention may be manufactured by a method as set out below. In a first step, there are provided one or more aerosol-generating elements comprising one or more sheets of aerosol-generating material. In a second step, the one or more aerosol-generating elements are assembled such that the elements extend in a longitudinal direction. In a third step, the assembled elements are circumscribed with a wrapper to form a continuous rod of aerosol-generating substrate. In a fourth step, the continuous rod is severed into a plurality of discrete rods of aerosol-generating substrate. In a fifth step, there is provided at least one further article element in substantial longitudinal alignment with one of the discrete rods. In a sixth step, the rod and the further article element are circumscribed with an outer wrapper to form an aerosol-generating article. In a seventh step, there is provided at least a gripping band for gripping the one or more aerosol-generating elements, the at least one band circumscribing the discrete rod of aerosol-generating substrate at a location along the length of the discrete rod.

In preferred embodiments of the method, the at least one gripping band is provided such that a centre of the at least one gripping band is spaced from both a distal end and a proximal end of the discrete rod by at least 25 percent of the length of the discrete rod.

In an embodiment, the step of providing the gripping band circumscribing the discrete rod of aerosol-generating substrate is carried out prior to the step of circumscribing the rod and the further article element with an outer wrapper to form an aerosol-generating article. Thus, the gripping band is comprised between the wrapper directly circumscribing the one or more elements and the outer wrapper and thus will not be visible for the consumer.

Preferably, the step of providing the gripping band circumscribing the discrete rod of aerosol-generating substrate comprises the step of providing a plurality of gripping bands circumscribing the continuous rod at distinct locations along the length of the continuous rod, and wherein in the step of severing the continuous rod into a plurality of discrete rods of aerosol-generating substrate the continuous rod is severed at intermediate locations along the length of the continuous rods, such that each discrete rod comprises a single gripping band.
In some embodiments, the gripping band comprises a heat-shrinkable material and the method comprises a further a step of applying heat to the gripping band prior to the aerosol-generating article being used.

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

Figure 1 shows a schematic longitudinal cross-sectional view of an aerosol-generating article for use with an aerosol-generating device comprising a heater element;

Figure 2 shows a schematic perspective view of an aerosol-generating substrate according to a first embodiment of the invention, with the gripping band in a stretched state;

Figure 3 shows a schematic perspective view of the aerosol-generating substrate of Figure 2, with the gripping band in place;

Figure 4 shows a schematic perspective view of an aerosol-generating substrate according to a second embodiment of the invention, with the gripping band in place and in a non-shrunk state;

Figure 5 shows a schematic perspective view of the aerosol-generating substrate of Figure 3, with the gripping band in place and in a shrunk state; and

Figure 6 shows a schematic longitudinal cross-sectional view of an aerosol-generating system comprising an electrically operated aerosol-generating device and the aerosol-generating article shown in Figure 1.

The aerosol-generating article 10 shown in Figure 1 comprises a rod of aerosol-generating substrate 12, a hollow cellulose acetate tube 14, a spacer element 16 and a mouthpiece filter 18. These four elements are arranged sequentially and in coaxial alignment and are circumscribed by a substrate wrapper 20 to form the aerosol-generating article 10. The aerosol-generating article 10 has a mouth end 22 and a distal end 24 located at the opposite end of the article to the mouth end 22. The aerosol-generating article 10 shown in Figure 1 is particularly suitable for use with an electrically operated aerosol-generating device comprising a heater for heating the rod of aerosol-generating substrate.

The rod of aerosol-generating substrate 12 has a length of approximately 12 millimetres and a diameter of approximately 7 millimetres. The rod 12 is cylindrical in shape and has a substantially circular cross-section.

An embodiment of a rod of aerosol-generating substrate 12 for use in the aerosol-generating article 10 of Figure 1 is shown in Figures 2 and 3. The rod 12 comprises a gathered crimped sheet 30 of homogenised tobacco material circumscribed by a paper wrapper 32. The gathered crimped sheet 30 extends in the longitudinal direction and has a length substantially identical to the length of the rod 12. Longitudinal channels extending through the rod 12 are internally defined by the gathered crimped sheet 30. Thus, the rod 12 is adapted to receive a heater blade of an aerosol-generating device, as described below, and to provide an air flow pathway through which air can be drawn through the rod 12 during use.
The rod 12 further comprises a gripping band 34 for gripping the gathered crimped sheet 30 at a location along the length of the rod 12. As shown in Figure 3, in this embodiment the gripping band 34 comprises an elastic material and a nominal inner diameter of the gripping band 34 is smaller than an outer diameter of the rod 12 of aerosol-generating substrate. In Figure 2 the gripping band 34 is shown in a deformed (that is, stretched) state.

Another embodiment of a rod of aerosol-generating substrate 12 for use in the aerosol-generating article 10 of Figure 1 is shown in Figures 4 and 5. The rod 12 comprises a gathered crimped sheet 50 of homogenised tobacco material circumscribed by a paper wrapper 52. The gathered crimped sheet 50 extends in the longitudinal direction and has a length substantially identical to the length of the rod 12. Longitudinal channels extending through the rod 12 are internally defined by the gathered crimped sheet 50. Thus, the rod 12 is adapted to receive a heater blade of an aerosol-generating device, as described below, and to provide an air flow pathway through which air can be drawn through the rod 12 during use.

The rod 12 further comprises a gripping band 54 for gripping the gathered crimped sheet 50 at a location along the length of the rod 12. In this embodiment the gripping band 54 comprises a heat-shrinkable material. In Figure 4, the gripping band 54 is shown in a non-shrunk state. A nominal diameter of the gripping band 54 is substantially identical to an outer diameter of the rod 42. Figure 5 shows the gripping band in a shrunk state. This may be achieved by applying heat to the gripping band 54.

Figure 6 shows a portion of an electrically operated aerosol-generating system 200 that utilises a heater blade 210 to heat the rod of aerosol-generating substrate 12 of the aerosol-generating article 10 shown in Figure 1. The heater blade 210 is mounted within an aerosol-generating article chamber within a housing of an electrically operated aerosol-generating device 212. The aerosol-generating device 212 defines a plurality of air holes 214 for allowing air to flow to the aerosol-generating article 10, as illustrated by the arrows in Figure 6. The aerosol-generating device 212 comprises a power supply and electronics, which are not shown in Figure 6.

The aerosol-generating article 10 shown in Figure 1 is designed to engage with the aerosol-generating device 212 shown in Figure 6 in order to be consumed. The user inserts the aerosol-generating article 10 into the aerosol-generating device 212 so that the heater blade 210 is inserted into the rod of aerosol-generating substrate 12, through the gathered crimped sheet of homogenised tobacco material 30. The mouthpiece filter 18 projects outwards from the mouth end of the device 212. Once the aerosol-generating article 10 is engaged with the aerosol-generating device 212, the user draws on the mouth end 22 of the aerosol-generating article 10 and the rod of aerosol-generating substrate 12 is heated by the heater blade 210 to a temperature sufficient to generate an aerosol from the rod of aerosol-generating substrate 12. The gripping band 34 holds the gathered crimped sheet 30 in a tight arrangement, such that, when after use
the heater blade 210 is extracted from the rod of aerosol-generating substrate 12, substantially no fragments or particles that may have become detached from the remainder of the gathered crimped sheet 30 are dislodged and extracted with the heater blade 210.

It will be appreciated that the aerosol-generating article 10 shown in Figure 1 may also be suitable for use with other types of aerosol-generating devices.
CLAIMS

1. An aerosol-generating article for producing an inhalable aerosol when heated, the aerosol-generating article comprising:
   a rod of aerosol-generating substrate having a length, wherein the rod of aerosol-generating substrate comprises an aerosol-generating element extending in the longitudinal direction and comprising one or more sheets of aerosol-generating material, the rod further comprising a wrapper circumscribing the aerosol-generating element; and
   at least one gripping band for gripping the aerosol-generating element, the at least one gripping band circumscribing the rod of aerosol-generating substrate at a location along the length of the rod.

2. An aerosol-generating article according to claim 1 wherein the rod of aerosol-generating substrate has a distal end and a proximal end opposite the distal end, a centre of the gripping band being spaced from both the distal end and the proximal end by at least 25 percent of the length of the rod.

3. An aerosol-generating article according to claim 2 wherein a centre of the gripping band being spaced from both the distal end and the proximal end by at least 33 percent of the length of the rod.

4. An aerosol-generating article according to any one of claims 1 to 3 wherein the one or more sheets of aerosol-generating material comprise one or more gathered sheets of homogenised tobacco material or a plurality of stacked sheets of homogenised tobacco material.

5. An aerosol-generating article according to any one of claims 1 to 4 wherein at least during use an inner diameter of the at least one gripping band is less than about 95 percent of the outer diameter of the rod of aerosol-generating substrate.

6. An aerosol-generating article according to any one of claims 1 to 5 wherein the at least one gripping band comprises a heat-shrinkable material.

7. A rod of aerosol-generating substrate for use in an aerosol-generating article, the rod having a length and comprising:
   an aerosol-generating element extending in the longitudinal direction and comprising one or more sheets of aerosol-generating material;
a wrapper circumscribing the aerosol-generating element; and
at least one gripping band for gripping the aerosol-generating element, the at least one gripping band circumscribing the wrapper at a location along the length of the rod.

5. A method of making a rod of aerosol-generating substrate for use in an aerosol-generating article, the method comprising the steps of:
providing an aerosol-generating element comprising one or more sheets of aerosol-generating material;
assembling the aerosol-generating element such that the element extends in a longitudinal direction;
circumscribing the assembled aerosol-generating element with a wrapper to form a continuous rod;
providing one or more gripping bands for gripping the aerosol-generating element, the one or more gripping bands circumscribing the continuous rod at distinct locations along the length of the continuous rod;
severing the continuous rod at intermediate locations along the length of the continuous rods to provide multiple discrete rods, such that each discrete rod comprises at least a gripping band.

9. A method according to claim 8 wherein each discrete rod has a distal end and a proximal end opposite the distal end, a centre of the at least one gripping band being spaced from both the distal end and the proximal end by at least 25 percent of the length of the discrete rod.

10. A method of making an aerosol-generating article, the method comprising the steps of:
providing an aerosol-generating element comprising one or more sheets of aerosol-generating material;
assembling the aerosol-generating element such that the element extends in a longitudinal direction;
circumscribing the assembled element with a wrapper to form a continuous rod of aerosol-generating substrate;
severing the continuous rod into a plurality of discrete rods of aerosol-generating substrate;
providing at least one further article element in substantial longitudinal alignment with one of the discrete rods;
circumscribing the rod and the further article element with an outer wrapper to form an aerosol-generating article;
providing a gripping band for gripping the aerosol-generating element, the band circumscribing the discrete rod of aerosol-generating substrate at a location along the length of the discrete rod.

11. A method according to claim 10 wherein the step of providing the gripping band circumscribing the discrete rod of aerosol-generating substrate is carried out prior to the step of circumscribing the rod and the further article element with an outer wrapper to form an aerosol-generating article.

12. A method according to claim 10 or 11 wherein the step of providing the gripping band circumscribing the discrete rod of aerosol-generating substrate comprises the step of providing a plurality of gripping bands circumscribing the continuous rod at distinct locations along the length of the continuous rod, and wherein in the step of severing the continuous rod into a plurality of discrete rods of aerosol-generating substrate the continuous rod is severed at intermediate locations along the length of the continuous rods, such that each discrete rod comprises a single gripping band.

13. A method according to any one of claims 10 to 12 wherein each discrete rod has a distal end and a proximal end opposite the distal end, a centre of the at least one gripping band being spaced from both the distal end and the proximal end by at least 25 percent of the length of the discrete rod.

14. A method according to claim 8, 9 or any one of claims 10 to 13 wherein the gripping band comprises a heat-shrinkable material, the method further comprising a step of applying heat to the gripping band.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
   Inv. A24D 1/00
   Add. A24F 47/00

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

B. FIELDS SEARCHED

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

Authorized officer Koob, Michael

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