

METHOD OF PRODUCING FILTER ELEMENTS FOR USE WITH HEATABLE TOBACCO PRODUCTS

TECHNICAL FIELD

- 5 The present invention relates to a filter element for use in a heatable tobacco product and a method of producing the same.

BACKGROUND

- 10 The following discussion of the background is intended to facilitate understanding of the present invention. However, it should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was published, known or a part of the common general knowledge in any jurisdiction as at the priority date of the application.

- 15 Heatable tobacco products (also known as heat-not-burn products) are tobacco products that produce a nicotine-containing aerosol/vapour by heating the tobacco products. Since the tobacco does not burn, the level of harmful chemicals in the vapour may be significantly reduced and 'second-hand smoke' can be mitigated. Further, little or no ash is produced from the heatable tobacco product, which provides additional benefits
20 of being environmentally friendly.

Some heatable tobacco products make use of specifically designed tobacco sticks. Such tobacco sticks typically include a tobacco substrate (or an aerosol-generating substrate), one or more filters, and/or one or more support elements.

- 25 In use, the tobacco stick may be inserted into a heating device or vice versa, which comprises one or more heating elements configured to generate and transmit heat to the tobacco substrate of the tobacco stick. For most of heatable tobacco products, the tobacco is heated up to a temperature that is lower than combustion temperature of
30 tobacco material. Temperature control is critical for heatable tobacco products, to avoid burning/combustion of the tobacco material. At the same time, it is also desirable to

maintain the tobacco substrate above a threshold temperature to ensure that sufficient amount of aerosol can be generated from the tobacco substrate for user inhalation.

Heat generated by the heating elements may be transmitted to other components of the tobacco sticks, for example, to the one or more filter and/or support elements located at the downstream of the tobacco substrate. In some tobacco heating devices, the heating element may take the form of a heating blade or a heating needle. In use, the heating blade or heating needle is disposed within or is penetrated into the tobacco substrate, and an end/tip portion of the heating blade or the heating needle may protrude out from the tobacco unit. The protruding portion of the heating element may cause the downstream component such as a filter element to melt, which may affect the functionality of the heatable tobacco product. The selection of materials to form the filter element are also further restricted to a range of high-temperature resistant materials in order to avoid severe degradation of the filter element as the heating device operates to heat the tobacco substrate. Further, the protruding portion of the heating element may cause more heat to be transmitted to the filter element and further downstream, causing a hot feeling on the lip or hand of the user who touches the heatable tobacco product. User experience is affected.

There exists a need to develop a filter element for use in a heatable tobacco product that ameliorates the afore-mentioned drawbacks at least in part.

SUMMARY

The disclosure seeks to provide methods for producing a filter body for attachment to a tobacco unit to form a heatable tobacco product.

According to one aspect of the disclosure there is a method for producing a heatable tobacco product, comprising the steps of providing a filter material; forming an elongate filter body with the filter material, the elongate filter body having a first surface at a first end; and making a recess on the first surface, the recess formed according to a pre-determined shape; wherein the elongate filter body is arranged adjoining a tobacco unit to form the heatable tobacco product, and the recess is shaped and dimensioned to

accommodate a portion of a heating element operable to heat the heatable tobacco product.

5 In some embodiments, the step of making the recess on the first surface includes the steps of forming a cutout part on the first surface of the first end according to the pre-determined shape; and removing the cutout part from the filter body.

In some embodiments, the step of making the recess includes the step of making a first and a second incision on the first surface to form the cutout part.

10

In some embodiments, the step of making the recess includes the step of applying heat to melt a portion of the first surface to form the recess.

15 In some embodiments, the step of making the recess includes applying mechanical force on the first surface to form a depression on a part or whole of the recess. The mechanical force may include the steps of punching (with a pin), poking, or using compressed air to push out the cutout part.

20 In some embodiments, the step of making the recess includes integrally molding the recess on the first surface while forming the elongate filter body.

In some embodiments, the step of making the recess includes extruding the filter material through a die to form the filter body with recess.

25 In some embodiments, the pre-determined shape is one of the following: a V-shaped notch, a rectangular prism, a triangular prism, a pyramid, a cylinder, a cone, and/or any other curved or angular shapes or one or more combinations of shapes.

In some embodiments, the step of forming the elongate filter body comprises:

- 30
- feeding the one or more filter materials to a forming machine;
 - stretching the one or more filter materials into a elongate filter strand by applying a mechanical force and/or heat; and

- compressing a plurality of elongate filter strands into the elongate filter body with a desired length.

In some embodiments, the one or more filter materials comprises one or more net materials.

5

In some embodiments, the method includes the step of circumscribing at least a part of the elongate filter body with one or more wrapping materials.

10 In some embodiments, the method further includes a step of providing a heat-insulating layer on at least a part of the filter element.

In some embodiments, the one or more filter materials comprise any one of the following materials: - at least one natural or synthetic fibrous material; at least one polymeric material; at least one resin material; and any combinations thereof.

15

In some embodiments, the one or more filter materials comprise one or more of the following materials: - natural plant fibers; natural animal fibers; carbonized plant fibers, carbonized animal fibers; synthetic polymer fibers; natural resin material; synthetic polymer resin; any combinations or derivatives thereof.

20

In some embodiments, the one or more filter materials comprises one or more of the following materials: - natural plant fiber, cotton; jute; hemp; bamboo fibers; bamboo charcoal fibers; natural animal fibers such as wool; silk; nylon; carbonized plant fiber, carbonized animal fiber, polyester fibers; polyimide fibers; polyethylene (PE);
25 polyethylene terephthalate (PET); polyethylene ether ketones (PEEK); polypropylene (PP); polytetrafluoroethylene (PTFE); polyvinylchloride (PVC), cellulose acetate (CA), starch based polymers, liquid crystal polymer material (LCP); polyimides; polyacrylonitrile (PAN); polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating,
30 laminate or mixed with any of the materials in this list; natural or synthetic rubber; paper; cork; carbon; graphene; any combinations or derivatives thereof.

According to another aspect of the disclosure there is a method for modifying a heatable tobacco product having at least one filter body and at least one tobacco unit including the steps of separating the at least one filter body from the at least one tobacco unit; making a recess on a first surface of the filter body, the recess formed according to a pre-determined shape; wherein the filter body is arranged adjoining a tobacco unit to form the heatable tobacco product, and the recess is shaped and dimensioned to accommodate a portion of a heating element operable to heat the heatable tobacco product. The filter body may or may not be attached to the at least one tobacco unit thereafter.

According to another aspect of the disclosure there is a method of using a heatable tobacco product having a filter body with recess formed according to a pre-determined shape, and a tobacco unit. The method comprises the step of inserting a heating element through the tobacco unit, wherein a part of the heating element is accommodated by the recess but not in contact with the filter body.

According to another aspect there is a filter element of a heatable tobacco product formed from one or more filter materials, wherein the filter element comprises a elongate filter body having a first surface and a recess formed on the first surface in a pre-determined shape; the recess on the first surface operable to accommodate a part of a heating element extending through the heatable tobacco product.

Other aspects of the invention will be apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments are described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates a filter element according to one embodiment and a heatable tobacco product comprising the filter element;

5 Figure 2 illustrates a filter element according to another embodiment and a heatable tobacco product comprising the filter element;

Figure 3A and 3B illustrate a filter element according to other embodiments and a heatable tobacco product comprising the filter element;

10 Figures 4A to 4C illustrates a filter element according to various embodiments and a heatable tobacco product coupled to a heating device;

Figure 5 illustrate a method of forming a filter element with a recess according to one embodiment; and

15

Figure 6 illustrate a method of forming a recess on the filter element.

Other arrangements are possible and it is appreciable that the accompanying drawings are not to be understood as superseding the generality of the preceding description of
20 the invention.

DETAILED DESCRIPTION

Particular embodiments are described with reference to the accompany drawings. The terminology used herein is for the purpose of describing particular embodiments only
25 and is not intended to limit the scope of the present invention. Other definitions for selected terms used herein may be found within the detailed description of the invention and apply throughout the description. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one ordinary skilled in the art to which the present invention belongs.

30 Where possible, the same reference numerals are used throughout the figures for clarity and consistency.

Throughout the specification, unless the context requires otherwise, the word “comprise” or variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

5

Throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including”, will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

10

Throughout the specification, unless the context requires otherwise, the word “have” or variations such as “has” or “having”, will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

15

Throughout the specification, unless the context requires otherwise, the term “tobacco” will be understood to include products prepared from a part of the tobacco plant, such as leaves, through the process of drying or curing, and further optional processes of aging, fermenting, flavouring etc., and to include any other products derived from any forms of tobacco leaves such as ground and reconstituted tobacco material.

20

Throughout the specification, unless stated otherwise, “heatable tobacco product” will be understood to include tobacco products containing a tobacco material to be heated, rather than combusted or burned as in conventional cigarettes. “Heatable tobacco product” may in some context be referred to as “heat-not-burn tobacco product” and in the description these terms may be used interchangeably. The tobacco material of a heatable tobacco product can be heated via an electrical power source functioning as a heating element at a temperature lower than the combustion point of the tobacco material and capable of producing vapors/aerosols containing nicotine and other chemicals suitable for consumption. It is appreciable that aerosol formation in a heatable tobacco product may be based on distillation and evaporation.

25

30

Throughout the specification, the term “layer” will be understood to depict a planar surface with a substantially higher length and/or width compared to thickness.

5 Throughout the specification, the term “downstream” is used to describe the relative positions of the different components or segments of a tobacco product in relation to the direction of the aerosol flow within the tobacco product, as a user draws on the tobacco product during normal consumption.

10 Throughout the specification, the term “recess” is used to describe a depression or an indented formation or a groove on a surface.

In accordance to one embodiment of the invention and with reference to Figure 1, there is provided a filter element 10 for use in a heatable tobacco product 100. The heatable tobacco product 100 may take a form resembling a cigarette stick, and may also be referred to as a heatable tobacco stick 100. The filter element 10 may be a elongate filter body.

20 The filter element 10 comprises or is formed from one or more filter materials. One non-limiting example of the filter element 10 as shown in Figure 1 to 6 can be formed into a cylindrical or a rod-like shape. It is appreciable that the filter element 10 may take any suitable shape according to various designs of the heatable tobacco product 100. In various embodiments, the filter element 10 comprises at least a first surface 14 at a first end of the filter element 10, where a recess 17 in a pre-determined shape is provided. The first surface 14 may be a substantially planar surface.

25 In various embodiments, the filter element 10 may be placed adjacent to and at the downstream of a tobacco unit 110 in the heatable tobacco product 100. As shown in Figure 1 to 3, the tobacco unit 110 may be at the extreme upstream of the heatable tobacco product 100, and the filter element 10 may adjoin the tobacco unit 110 at the first surface 14, so that a cavity is formed by the recess area 17 on the first surface 14 of the filter element 10 and the tobacco unit 110. The first surface 14 functions as an interface between the tobacco unit 110 and filter element 10.

As illustrated in Figure 4A to 4C, the heatable tobacco product 100 comprising the filter element 10 may be particularly suitable for use with a heating device 200 comprising one or more heating elements 210 taking the form of the following non-limiting examples such as heating pins, blades, plates, coils or ribbons. In use, the heatable tobacco product 100 is mounted onto the heating device 200, whereby the heating element 210 is inserted into or is disposed inside the tobacco unit 110. In various embodiments, the heating element 210, in the form of a heating blade and/or a heating needle, may be arranged to extend through the tobacco unit 110 along a longitudinal axis of the tobacco unit 110 when the heatable tobacco product 100 is mounted onto the heating device 200. The tobacco unit 110 is configured to generate a tobacco-infused aerosol when heated by the heating element 210 disposed therein, which is drawn through the filter element 10 and through other downstream components as the user consumes the tobacco product from a mouth end of the tobacco stick 100.

The heating needle/blade operates as a heat transmitter for heating the tobacco unit, and may provide the benefits of improving the heating and aerosol generating efficiency of the system. The internal heat source generates thermal energy at a central part of the tobacco unit 110, which is then transmitted to the edge part of the tobacco unit 100. Ideally, the length of the heating blade/needle 210 should be substantially equal to the length of the tobacco unit 110. More specifically, when the heatable tobacco product is mounted onto the heating device, the heating blade/needle 210 should ideally extend a length along a longitudinal axis of the tobacco unit 110 from one end to another end of the tobacco unit 110. In other words, the length of the heating element 210 should be the same as or not shorter than the length of the tobacco unit 110, such that the tobacco unit 110 can be heated simultaneously and at substantially the same temperature level along its longitudinal axis by the heating element 210.

However, the length of the heating blade/needle 210 and the length of the tobacco unit 10 may not always match each other due to manufacturing variations. Further, when the heatable tobacco product 100 is mounted onto the heating device 200 by a user or as the heatable tobacco product 100 and the heating device 200 are assembled as part of

the manufacturing process, the tobacco unit 10 may bend and/or be distorted slightly due to the handling and due to the relatively weak mechanical strength of the tobacco unit 110. The slight bending/distortion caused by handling during use and during the manufacturing process may not have any material impact on the functionality of the
5 heatable tobacco product, however, it may result in a tip portion of the heating blade/needle to protrude out from the tobacco unit 100. As can be seen in Figure 4A to 4C, an end/tip portion of the heating element 210 is protruding out from the tobacco unit 110 and extends into a neighboring component which is the filter element 10. The end/tip portion of the heating element 210 that protrude out from the tobacco unit 110
10 is referred to as a protruding part of the heating element 210.

In various embodiments, the recess of 17 the filter element 10, or more specifically the cavity formed by the recess 17, is adapted to accommodate the protruding part of the heating element 210.

15 In various embodiments, the recess 17 is configured such that a gap may be formed between the protruding part of the heating element 210 and the filter element 10. In other words, the recess 17 prevents the protruding part of the heating element 210 and the filter element 10 from coming into contact with each other.

20 In various embodiments, the recess 17 may be configured to be shaped and/or dimensioned with any curved or angular geometry suitable for containing the protruding portion of the heating element 210. Figures 1 to 3 illustrate three non-limiting examples of the filter element 10 with a recess 17. As shown in Figure 1, the recess 17 formed on the first surface 14 of the filter element 10 may be in the form of a
25 V-shaped notch or akin to a triangular prism. In another example shown in Figure 2, the recess 17 is in the form of a rectangular-based notch or a shape akin to a rectangular prism. In another example shown in Figure 4, the recess 17 is in cylindrical shape. It is appreciable that recess may take any other suitable forms so as to allow the filter
30 element 10 and the protruding part of the heating element 210 to be separated by a sufficient distance.

In some embodiments, the minimum distance of the gap made by the recess to any part of the heating element can be between 0.10 mm and 2 mm (boundary values included).

The filter element 10 with the recess 17 is advantageous in at least in the following aspects. Firstly, typical heating temperatures of the heating element 210 during operation of the heating device 200 can be in a range of 280°C to 350°C. The heating element 210 at such elevated heating temperatures may cause the filter element 10 to melt or degrade or deform if it comes in contact with the filter element 10. The cavity provided by the recess 17 effectively separates the protruding part of the heating element 210 and the filter element 10 so there is no direct contact between the protruding part and the filter element 10. This configuration minimizes any heat by conduction received at the filter element 10 and thus reduces the risks of melting or degradation or deformation of the filter element 10.

Further, for a non-disposable and reusable type heating device, the heating element 210 may be inserted into heatable tobacco products 100 multiple times for repeated uses. If the protruding portion of the heating element 210 causes the filter materials to melt, and consequently causes the molten filter materials to stick or adhere on the heating element 210, it may be more difficult for a user to extract the heatable tobacco product 100 out from the heating device 200. Also, the molten filter materials stuck on the heating element 210 may be difficult to be removed, and may accumulate on the heating element 210 at the protruding portion after multiple uses. This may shorten the lifespan of the heating element 210 and may cause mal-function of the heating device 200, which is undesirable.

In various embodiments, the gap or space between the heating element 210 and the filter element 10 may be void of any materials, that is, an air gap is formed between the heating element 210 and the filter element 10. In some embodiments, the gap or part of the gap may be layered or filled with a heat insulating material for better heat insulation.

In various embodiments, the one or more filter elements 10 can be any one of the following types of filter:- a fibrous tow filter, a net filter, film filter, foil filter, mesh

filter, fabric filter, fabric mesh filter, sheet filter, wrapped sheet filter, wrapped sheet filter after cut/sliced, wrapped filament filter, spongy filter, laminated filter, wafer filter, honey-comb structure filter, extruded or molded filter, filter with material that is sliced and wrapped, filter with shredded material, bundled soft tube filter, bundled hollow tube filter, bundled yarn filter, bundled sheet filter and bundled sheet filter and any combinations and derivatives thereof. In some embodiments, the filter element 10 may comprise a porous material such as a polymeric, plastics or paper foam.

10 In various embodiments, the filter element 10 may be formed from or comprise one or more of the following materials:- natural plant fibers including, but not limited to, cotton, jute, hemp, charcoal fibers such as bamboo charcoal fiber; natural animal fiber such as wool, silk, any other natural plant or animal fibers, and any carbonized plant fibers, carbonized animal fibers,; synthetic fibers including, but not limited to, nylon and VectranTM; fabric materials including, but not limited to, woven or non-woven fabric/cloth; plastic materials including, but not limited to, polyethylene (PE), polyethylene terephthalate (PET), polyethylene ether ketones (PEEK), polypropylene (PP), polytetrafluoroethylene (PTFE) such as TeflonTM, polyvinylchloride (PVC), cellulose acetate (CA), other starch based polymers, liquid crystal polymer material (LCP), and all other suitable plastic materials and plastic derivatives; resin materials including, but not limited to, polyimide, polyacrylonitrile (PAN) and other polymer resins, polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with any of the materials in this list natural or synthetic rubber and its derivatives; paper, cork and other similar materials; and/or any combinations thereof. It is appreciable that the filter elements 24 can be formed from any suitable materials, not limiting to the materials listed herein.

30 In various embodiments, the filter element 10 can be formed from any suitable materials that can withstand temperatures of up to 180°C and above without considerable deformation or degradation.

In some embodiments, the filter element 10 can be a tow filter comprising a bundle of acetate short fibers, which may also be used in conventional cigarettes. In some embodiments, the filter element 10 may be made of a charcoal material or may include
5 certain amount of carbon compound. The carbon compound may be an active carbon component, which can include a highly porous structure to provide for improved filtration efficiency.

In some embodiments, for example in accordance to the embodiment shown in Figure
10 3C, the filter element 10 can be a net filter, which is specifically designed for use in a heatable tobacco product 100. The net filter may be formed from one or more of the following materials (which may be plastic or non-plastic): VectranTM, polyethylene (PE), polypropylene (PP), polyvinylchloride (PVC), polyethylene terephthalate (PET), polyether ether ketone (PEEK), cellulose acetate (CA), Fluorinated ethylene propylene
15 (FEP) plastic, Polyurethane (PUR) Plastic, Polytetrafluoroethylene (PTFE), Liquid Crystal Polymer (LCP), polyimide, polyacrylonitrile (PAN) and other polymer resins, polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with any of the materials in this list natural plant fibers such as jute, hemp and others, natural
20 animal fibers such as silk, wool and others, carbonized natural plant fibers such as bamboo charcoal fiber and others, carbonized animal fibers, charcoal fibers, natural or synthetic rubber and its derivatives, carbon, graphite, liquid wood, Starch made polymer, natural fibre, synthetic fibre, biodegradable fiber or non-biodegradable fiber, one or more composite or derivatives of the above mentioned materials, possible
25 combinations of one or more of the above materials or/and other food grade non-toxic materials suitable as filter or any other material that can withstand temperatures of up to 180°C and above without considerable deformation or degradation. The net filter may provide better delivery compared with traditional acetate tow filter, in particular with relatively lower pressure drop across the heatable tobacco product 100.

30 In some embodiments, the filter element 10 can be made initially from one or more base fibers. The base fibers can be woven, shaped or processed into the respective filter type.

For example, an animal fiber such as silk can be processed into threads, and then woven into a fabric filter.

In various embodiments, the filter element 10 may further comprise one or more wrapping materials 22 circumscribing at least part of the filter element 10. In various embodiments, the one or more wrapping materials 22 may comprise one or more thin layers of suitable wrapping materials 22, which provide for sufficient stiffness to facilitate the handling and/or to improve the aesthetical appearance of the heatable tobacco product.

In some embodiments, the wrapping material 22 may be formed from natural plant or animal fibers, formed into a single sheet by being woven into fabric or cloth or other technique. Natural fibers include, but not limited to, plant or carbonized plant fibers such as bamboo, jute, hemp, bamboo charcoal fibers and other charcoal fibers; animal or carbonized animal fibers such as wool, silk; and any other plant or animal fiber carbonized or non-carbonized; and/or combinations thereof. The wrapping material 22 may also be formed from or comprise of combinations of natural plant or animal fibers, formed into sheets by being woven into fabric or cloth or other technique and laminated or pressed onto one or more sheets of natural plant or animal material or it can be any other material that can withstand temperatures of up to 180°C and above without considerable deformation or degradation.

In some embodiments, the wrapping material 22 may be formed from a single sheet of plastic fiber or synthetic fiber woven into or made into a sheet. The plastic materials can include but are not limited to such plastics as nylon and VectranTM, polyethylene (PE), polyethylene terephthalate (PET), polyethylene ether ketones (PEEK), polypropylene (PP), polytetrafluoroethylene (PTFE) such as TeflonTM, polyvinylchloride (PVC), cellulose acetate (CA), other starch based polymers, liquid crystal polymer material (LCP) such as VectraTM and VectranTM, polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with any of the materials in this list and any other non-stick and/or non-toxic plastic types and derivatives. The

wrapping material 22 may also be formed from sheets of plastic fiber or synthetic fiber woven into or made into a sheet and laminated or pressed onto one or more plastic fiber or synthetic plastic fiber sheet.

- 5 In some embodiments, the wrapping material 22 may also be a combination of two or more of natural (plant or animal) material sheets and plastic material sheets, laminated or pressed onto one or more of each said material (natural or plastic).

10 In other embodiments, the wrapping material 22 may be a metallic sheet made of aluminium, copper or other metallic foils. The wrapping material can also be a metal sheet laminated or pressed onto another metal sheet of the same material, another metallic material or can be any other material able to withstand up to 180°C and above without significant deformation.

- 15 In various embodiments, the filter element 10 or part of the filter element 10 may be coated with a heat-insulating layer 25 comprising a heat-insulating material or materials with a substantially low thermal conductivity.

20 In various embodiments, the heat insulating layer 25 may be formed using any suitable processes, for example, spraying, coating, laminating, or any other thin-film application technologies, and that it may be applied before or after the application of any one or more layers of the wrapping materials.

25 In some embodiments, the heat insulating layer 25 may be applied onto or attached onto any layer of the wrapping material 22. For example, as shown in Figure 4, a heat insulation food grade glue or other high temperature resistant films may be applied onto or attached onto a tipping paper which is an outmost layer of the wrapping material 22. Accordingly, the heatable tobacco product is advantageous in that heat transmitted to the outermost layer or the wrapping material 33 of the heatable tobacco product 20 can
30 be mitigated to prevent the hot feeling on the end user's hands and/or lips. User experience is improved.

In some embodiments, the heat insulating layer 25 may form an innermost layer prior to the application of the one or more layers of the wrapping materials, for example, as shown in Figure 1 and 3. A heat insulation food grade glue or other high temperature resistant films may be applied onto or attached onto the surface of the filter element 10 directly. The heat-insulating layer 25 may follow the outline of the filter element 10 to cover part of or the entire outer surface of the filter element.

In some embodiments, the heat-insulating layer 25 may also be formed at the recess 17 of the filter element 10. The heat-insulating layer 25 at the recess 17 provides for an additional layer of protection to prevent the filter materials near the protruding part of the heating element 210 from being melted, deformed or degraded.

In some embodiments, the heat-insulating layer 25 may be a material having a substantially high permeability or may be perforated during the manufacturing process, which provides the additional benefits of reducing the content of tar or other volatile substances from the aerosol to be inhaled by the user.

It is appreciable that the filter element 10 may comprises more than one heat-insulating layer 25, and the heat-insulating layer 25 may be provided or formed on different parts of the filter element 10.

In some embodiments, the thickness of the heat-insulating layer 25 is between 50microns and 150 microns (boundary values inclusive). In some embodiments, where the heat insulation layer is a food grade glue, the thickness can be between 3 and 10 microns.

It is further appreciable that the shapes and dimensions provided for the filter element 10, the recess 17, the wrapping material 22 and the heat-insulating layer 25 according to the embodiments described above and illustrated in Figure 1 to 6 are merely exemplary, and that suitable alternative shapes and dimensions may be chosen according to the design requirements of the filter element 10.

In accordance with another aspect of the invention, there is provided a method of producing a filter element 10 with a recess 17.

5 In a first step, one or more filter materials are provided and prepared for forming the filter element 10. In various embodiments, the one or more filter materials which may be used to form and realize the filter element 10 comprise any suitable material or materials as described above.

10 One or more filter materials may be selected to form a filter element 10 with desired physical and/or chemical properties. For example, the one or more filter materials may be selected to form a filter element with a substantial stiffness. Advantageously, as the filter element 10 experiences any external force, for example a compression force when being attached to other components of the heatable tobacco product during the manufacturing process or when the heatable tobacco product is inserted into a heating
15 device by a user, it may be less prone to any deformation. In some embodiments, the one or more filter materials comprise an adhesive, or a plasticizer. The adhesive or plasticizer has the function of a bonding constituent, which may further strengthen the overall structure of the filter body formed. In some embodiments, the one or more filter materials selected may include an adsorbent, an absorbent, or a substance that may
20 perform both of these functions, such as, activated carbon, for enhanced filtration effect. Alternatively or additionally, the filter material may include a flavor release agent.

In a subsequent step, a filter element 10 (such as a filter body) is formed from the one or more filter materials. The filter element 10 may be formed into an elongated shape
25 with at least one planar surface at a first end. The filter body may be formed using one single process, for example, the one or more filter materials may be molded into the filter element 10 in a final desired shape.

30 Alternatively, a continuous filter body for further production of the filter element 10 (or discrete filter bodies) may be first formed from the one or more filter materials. Thereafter, one or more further machining and shaping techniques may be used to process the continuous filter body into a plurality of filter elements 10 with a desired shape and dimension.

In some embodiments, the one or more filter materials may be fed into a forming machine. The forming machine may have a tubular forming element adapted to allow the one or more filter materials to pass through to form into the continuous filter body.

5

In some embodiments, the tubular forming element defines an internal channel substantially of cylindrical cross section, having a longitudinal axis, connecting an inlet of the tubular forming element to an outlet of the same. The inner wall of the tubular forming element defines the outer surface of the continuous filter body and determine, among others, its diameter. The inner wall of the tubular forming element compresses the one or more filter materials into a tube shape continuous filter body for further production of the filter elements 10. In some embodiments, the forming machine may be configured to provide an elevated temperature at the tubular forming element, to assist in the forming of the continuous filter body.

10

15

In some embodiments, the forming machine may be an extruder, whereby the one or more filter materials, which may be prepared in the form of granules and melt into a liquid-phase or a viscous material, are forced through a die, forming a long tube-like shape, further used for the production of filter elements 10.

20

In some embodiments, the forming machine may be an injection molding device. The one or more filter materials, which are molten, are injected into a mold and forms into a continuous filter body used for further production of multiple filter elements. Alternatively, the one or more filter materials are directly formed into the filter element in the final desired shape from a one single molding process, and the additional step of cutting the continuous filter body in portions to form a plurality of filter elements can be eliminated.

25

In some embodiments, one or more types of fibers or one or more fabric materials formed from the fibers may be processed into the filter element 10 in a pre-defined shape. For example, an animal fiber such as silk can be processed into threads, and then

30

woven into a fabric filter. The threads made of the animal fibers may also be woven into a piece of cloth, which is then rolled or crimped into the shape of the filter element.

It is appreciable that other forming and shaping techniques, or other types of forming devices, may be used for forming other types of filter elements including, but not limited to, forming a fibrous tow filter; a film filter; a foil filter; a mesh filter; a sheet filter; spongy filter; a laminated filter; a wafer filter; a, honey-comb structure filter, bundled soft tube filter, bundled hollow tube filter, bundled yarn filter, bundled sheet filter and bundled sheet filter or any derivatives thereof.

Reference is made to Figure 5, which provides a non-limiting example of the method of forming a net filter using the forming machine.

Suitable filter materials (which may be plastic or non-plastic) for forming a net filter include, but not limited to VectranTM, polyethylene (PE), polypropylene (PP), polyvinylchloride (PVC), polyethylene terephthalate (PET), polyether ether ketone (PEEK), cellulose acetate (CA), Fluorinated ethylene propylene (FEP) plastic, Polyurethane (PUR) Plastic, Polytetrafluoroethylene (PTFE), Liquid Crystal Polymer (LCP), polyimide, polyacrylonitrile (PAN) and other polymer resins, polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with any of the materials in this list natural plant fibers such as jute, hemp and others, natural animal fibers such as silk, wool and others, carbonized natural plant fibers such as bamboo charcoal fiber and others, carbonized animal fibers, charcoal fibers, natural or synthetic rubber and its derivatives, carbon, graphite, liquid wood, starch made polymer, natural fibre, synthetic fibre, biodegradable fiber or non-biodegradable fiber, one or more composite or derivatives of the above mentioned materials, and possible combinations of one or more of the above materials.

In a step 301, a net material formed from one or more of the above filter materials is prepared and provided in a gathered form. The net material may be formed by using a plastic extrusion process or by using a knitting process, and may have various mesh

shapes, sizes, width, length and diameter according to requirements. A non-limiting example of the net material is shown in Figure 5, which takes the form of a tubular net with square-shape mesh openings. The net material is gathered and provided in a roll to facilitate easy handling. The tubular net material is advantageous in that the net structure has a high tensile strength and a substantially high flexibility and/or stretchability along various directions. The strength and flexibility provide the benefits of facilitating easy processing and allowing the net material to be formed into the desired dimension in a relatively easy manner.

- 10 In a step 302, the net filter material is fed into a forming machine or a tubular forming element of the forming machine. As the net filter material passes through the tubular forming element, it gets compressed into a desired diameter and forms into a continuous filter body or a filter tube. The flexibility of the net filter material allows it to better conform to the shape of the inner channel of the tubular forming element.
- 15 Manufacturing variation is minimized.

- In a step 303 and step 304, the continuous filter body is wrapped with one or more wrapping materials. The wrapping materials may comprise a paper, plastic or fabric wrapper. For example, as shown in Figure 5, the wrapping material may be aligned along the continuous filter body, and the seaming edges maybe sealed by using an adhesive or by using other methods. In some embodiments, the continuous filter body material is first produced and then further along the process a secondary tubular material is produced around it and hardened by a chemical or steam process for better structural integrity.

25

In a Step 305, the continuous filter body is cut into a plurality of filter elements 10 with a desired length for further processing.

- 30 The resultant filter element 10 formed from the above-described method has an integral and uniform net or porous structure. The porosity of the net filter element 10 is determined by the net structure of the starting net filter material (e.g. the size and shape

of the openings), the compression ratio, and other process parameters (e.g. the feeding speed, and if temperature inside the tubular forming element etc.). A wide range of materials may be selected for forming the net filter with different properties, for example, with different weight, with a higher or lower temperature resistance and etc.

- 5 Depending on the system requirements, the process can be adapted and controlled to produce a net filter element 10 with a desired property.

10 In a Step 306, a recess 17 is formed on the first surface of the filter element 10. The recess 17 may be introduced on the first surface by using different shaping and machining techniques, or using other methods, according to a pre-determined shape.

In some embodiments, a cut-out part is formed on the first surface 14 according to the pre-determined shape, and the cut-out part is subsequently removed from the filter element to form the recess 17 on the first surface 14.

15

In various embodiments, the cutout part may be formed by making at least a first and a second incision on the first surface 14 of the filter element 10. More specifically, a cutting tool may be used to remove a part of the filter element 10. The cutting process may involve multiple cutting or incision actions. It is appreciable that the number of cutting or incision actions required for forming the cutout part depend on the desired shape and dimension of the recess 17 to be formed. The cutting or incision actions may take place along multiple strokes, whereby the starting and/end points and the length of each cutting stroke is controlled to make a cutout part according to the pre-determined shape.

20

25 As a non-limiting example, Figure 6 illustrates a cutting process for creating or forming a V-shaped notch or V-shaped recess 14 on the filter element 10.

30

As shown in Figure 6, in an optional Step 306-a, a continuous filter body, which may be produced from an extrusion process, may be cut and sized into a filter element 10 with a desired length, and at least one substantially planar surface is formed at a first end of the filter element 10, which is also referred to as the first surface 10. This step

may not be required, if during an earlier forming process, the filter element has already been formed into a rod-like shape with the desired length and with the first planer surface.

- 5 In Step 306-b, a first cutting stroke is applied on one of the first surface 14 of the filter element 10. The first cutting stroke is applied at a pre-determined angle with respect to a longitudinal axis A-A' of the filter element, and the cutting tool or the cutter is controlled to stop at a point B on the longitudinal axis A-A'. In other words, first cutting stroke is applied to form a cutting surface extending from the first surface 14 of filter
10 element 10 to the longitudinal axis A-A' of the filter element at an angle, without crossing the longitudinal axis A-A'.

In Step 306-c, a second cutting stroke is applied at the same angle with respect to the longitude axis A-A' of the filter element. Similarly, the cutting tool or the cuter stops at
15 the same location B on the longitudinal axis A-A'. A second cutting surface is at the opposite side of the longitudinal axis A-A' and is symmetrically formed with respect to the first cutting surface. A cutout part in a V-shape or a shape akin to triangular prism is formed, which may be located at the center of the first surface of the filter element as shown in Figure 6.

20

The size of the V-shaped notch or the V-shaped recess 17 is primarily determined by the included angle, i.e. the angle formed between the two cutting surfaces. For positioning the cutting tool or a cutting edge of the cutting tool, markings or cutting patterns can be drawn or placed on the first surface prior to the cutting process. The
25 circular cross-sectional view of the filter element 10 in Figure 1 shows an example of markings or cutting patterns which may be used for cutting a V-shaped cutout part. The three dotted lines, respectively correspond to the starting position of the first cutting stroke, the position of a hypothetical plane along the longitudinal axis A-A' of the filter element where the cutting surface should stop at, and the starting position of the second
30 cutting stroke. The cutting process may be manually done by an operator. Alternatively, the cutting tool may be digitally controlled by a computing device for improved precision.

As the cutting process completes, the cutout part can be removed easily from the filter element 10, leaving a V-shaped notch or V-shaped recess 17 on the first surface 14 of the filter element 10. Advantageously, the removal of the V-shaped cutout part can be done in a relatively easy manner, because a cutout part in the V-shape tends to egress out from the filter element. This cutting process of creating the recess 14 is a relatively easy-to-control and stable process that introduce less degree of manufacturing process variation.

Similar cutting process may be applied to create a rectangular based notch or recess as shown in Figure 2, whereby at least three cutting strokes may be required. It is appreciable that one or more further steps such as a further trimming step may be applied to adjust the size and dimension of the recess 17 after the cutting process in order to conform the recess 17 better to the desired shape.

In some embodiments, a laser cutting process may be used to form the recess 17, which may provide for better precision and may be used to form more complex recess geometry, for example a cylindrical shaped recess as shown in Figure 3.

The cutout part in different shapes may be removed from the filter element with the assistance of a pin inserted into the cutout part, by poking on the cut out part with a tool, and/or by using compressed air to push out the cut out part.

In combination with or as an alternative to the above-described cutting process, other techniques may be used to introduce the recess 17 on the filter element 10, which may involve the application of a mechanical force and/or heat. For example, a stamping press or punching process may be used to introduce a depression or a dent on the first surface 14 of the filter element 10, corresponding to the recess 17. The shape and dimension of the recess 17 to be formed will be primarily determined by the shape of the die of the stamping press or punching tool.

Another technique that may be used to form the recess 17 is to apply heat to melt away part of the filter element 10. This technique may be suitable for filter elements 10 formed from filter materials having relatively low melting temperatures, for example filter elements formed from thermoplastic materials. Control of the heating temperature is critical so as to be sufficiently high to melt the filter materials and at the same time to minimize the degradation and/or deformation of the filter materials during such a recess forming process.

Another technique that may be used to form the recess 17 is via the use of a grinding or drilling tool to wear away filter material and form the recess 17 for example, using a high-speed drill that forms a cylinder when rotating to form a cylindrical recess. A drill with a pointed grinding end can create a conical recess for example. Such drilling techniques may be suitable for filter elements 10 that are significantly harder like the elements produced from plastic extrusion or filter materials that have higher melting temperatures.

Prior to or after step 303 and 304 of providing any one or more layers of the wrapping materials, a heat insulating layer 25 may be formed on at least part of the filter element 10. Suitable processes for forming the heating insulating layer 25 include, but are not limited to spraying, coating, laminating, or any other thin-film application technologies.

The heat insulating layer 25 may form an innermost layer on the outer surface of the filter element 10, prior to the application of the one or more layers of the wrapping materials 22, for example, as shown in Figure 1 and 2. A heat insulation food grade glue or other high temperature resistant films may be applied onto or attached onto the surface of the filter element 10 directly. The heat-insulating layer 25 may follow the outline of the filter element 10 to cover part of or the entire outer surface of the filter element 10.

Alternatively, the heat insulation food grade glue or other high temperature resistant films may be applied onto or attached onto the wrapping materials or part of the wrapping materials, as shown in Figure 4.

The heat-insulating layer 25 may also be formed at the recess 17 of the filter element 10. The heat-insulating layer 25 at the recess 17 provides for an additional layer of protection to prevent the filter materials near the protruding part of the heating element
5 from being melted, deformed or degraded.

The filter element 10 is then incorporated into the heatable tobacco product in further assembly processes. The first surface 14 of the filter element 10 with the recess 17 is arranged to be adjacent to and aligned with the tobacco unit 110, such that the
10 protruding tip portion of the heating element 210 extending through the tobacco unit 10 can be disposed or contained inside the cavity provided by the recess 10, as shown in Figure 4.

The above is description of a filter element for use in a heatable tobacco product and method of making the same. It will be apparent that various other modifications and adaptations of the invention will be apparent to the person skilled in the art after reading
15 the foregoing disclosure without departing from the spirit and scope of the invention. It is intended that all such modifications and adaptations come within the scope of the appended claims.

20

Further, it is to be appreciated that features from various embodiment(s), may be combined to form one or more additional embodiments.

Reference

	10	filter element
	14	first surface
5	17	recess
	22	wrapping material
	24	tow filter
	25	heat-insulating layer
	26	net filter
10	100	heatable tobacco product
	110	tobacco unit
	200	heating device
	210	heating element
	301	step of providing one or more filter materials
15	302	step of forming a continuous filter body
	303	step of providing one or more wrapping materials
	304	step of sealing edges of one or more wrapping materials
	305	step of processing a continuous filter body into plurality of filter elements
20	306	step of forming a recess on a first surface of a net filter element
	306-a	a first optional step of forming a recess on a first surface of a net filter element
	306-b	a further step of forming a recess on a first surface of a net filter element
25	306-c	a further step of forming a recess on a first surface of a net filter element

CLAIMS

1. A method of producing a heatable tobacco product, comprising the steps of:

- providing a filter material;
- 5 - forming an elongate filter body with the filter material, the elongate filter body having a first surface at a first end; and
- making a recess on the first surface, the recess formed according to a pre-determined shape;

10 wherein the elongate filter body is arranged adjoining a tobacco unit at the first surface to form the heatable tobacco product, and

wherein the recess is shaped and dimensioned to accommodate a protruding portion of a heating element when the heating element is inserted through the tobacco unit, such that a gap is formed between the protruding portion of the heating element and the filter material.

15

2. The method according to claim 1, wherein the step of making the recess on the first surface includes the steps of forming a cutout part on the first surface of the first end according to the pre-determined shape; and removing the cutout part from the filter body.

20

3. The method according to claim 2, wherein the step of making the recess includes the step of making a first and a second incision on the first surface to form the cutout part.

25 4. The method according to claim 1, wherein the step of making the recess includes the step of applying heat to melt a portion of the first surface to form the recess.

30

5. The method according to claim 1, wherein the step of making the recess includes applying mechanical force on the first surface to form a depression on a part or whole of the recess.

6. The method according to claim 1, wherein the step of making the recess includes integrally molding the recess on the first surface while forming the elongate filter body

or extruding the filter material through a die to form the elongated filter body with the recess.

5 7. The method according to claim 1, wherein the step of making the recess includes grinding out the recess on the first surface with a grinder shaping the recess according to how it rotates.

10 8. The method according to any one of claims 1 to 6, wherein the pre-determined shape is one of the following: a V-shaped notch, a rectangular prism, a triangular prism, a pyramid, a cylinder, a cone, and/or any other curved or angular shapes or combinations of shapes.

9. The method according to any one of claims 1 to 7, wherein the step of forming the elongate filter body comprises:

15 - feeding the one or more filter materials to a forming machine;
 - stretching the one or more filter materials into a elongate filter strand by applying a mechanical force and/or heat; and
 - compressing a plurality of elongate filter strands into the elongate filter body with a desired length.

20 10. The method according to claim 9, wherein the one or more filter materials comprises one or more net materials.

25 11. The method according to any one of claims 1 to 10, further comprising a step of circumscribing at least part of the elongate filter body with one or more wrapping materials.

12. The method according to any one of claims 1 to 11, further comprising a step of providing a heat-insulating layer on at least a part of the filter element.

30 13. The method according to any one or claims 1 to 12, wherein the one or more filter materials comprises any one of the following materials: - at least one natural or

synthetic fibrous material; at least one polymeric material; at least one resin material; and any combinations thereof.

14. The method according to any one of claims 1 to 13, wherein the one or more filter materials comprise one or more of the following materials: - natural plant fibers; natural animal fibers; carbonized plant fibers, carbonized animal fibers; synthetic polymer fibers; natural resin material; synthetic polymer resin; any combinations or derivatives thereof.

15. The method according to any one of claims 1 to 14, wherein the one or more filter materials comprises one or more of the following materials: - natural plant fiber, cotton; jute; hemp; bamboo fibers; bamboo charcoal fibers; natural animal fibers such as wool; silk; nylon; carbonized plant fiber, carbonized animal fiber, polyester fibers; polyimide fibers; polyethylene (PE); polyethylene terephthalate (PET); polyethylene ether ketones (PEEK); polypropylene (PP); polytetrafluoroethylene (PTFE); polyvinylchloride (PVC), cellulose acetate (CA), starch based polymers, liquid crystal polymer material (LCP); polyacrylonitrile (PAN); polysiloxanes such as Silicone in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with any of the materials in this list natural or synthetic rubber; paper; cork; carbon; graphene; any combinations or derivatives thereof.

16. A method for modifying a heatable tobacco product having at least one filter body formed from a filter material and at least one tobacco unit including the steps of: -

(a.) separating the at least one filter body from the at least one tobacco unit; and

(b.) making a recess on a first surface of the filter body, the recess formed according to a pre-determined shape;

wherein the filter body is arranged adjoining a tobacco unit at the first surface to form the heatable tobacco product, and the recess is shaped and dimensioned to accommodate a protruding portion of a heating element when the heating element is inserted through the tobacco unit, such that a gap is formed between the protruding portion of the heating element and the filter material.

17. A method of using a heatable tobacco product having a filter body formed from a filter material, the filter body has a recess on a first surface at a first end formed according to a pre-determined shape, and a tobacco unit adjoining the filter body at the first surface, wherein the method comprises the step of inserting a heating element
5 through the tobacco unit such that a protruding portion of the heating element is accommodated by the recess, and a gap is formed between the protruding portion of the heating element and the filter material.

18. A filter element of a heatable tobacco product formed from one or more filter
10 materials, wherein the filter element comprises an elongate filter body having a first surface and a recess formed on the first surface in a pre-determined shape; the recess on the first surface is shaped and dimensioned to accommodate a protruding portion of a heating element when the heating element is inserted through the tobacco unit for heating the tobacco unit, such that a gap is formed between the protruding portion of
15 the heating element and the one or more filter materials. .