

FILTER ELEMENT

TECHNICAL FIELD

The present disclosure relates to a filter element for use a tobacco product or the like.

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BACKGROUND

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

Filter elements used in tobacco products such as cigarettes and cigars are also known as a filter tip or a cigarette butt, and these are typically formed from bundles of cellulose acetate fibres or from convoluted paper. In some filters, activated charcoal may be
15 added to improve the efficiency of the filter.

The cellulose acetate and paper modify the particulate smoke phase by particle retention or filtration, and the activated charcoal content in the filter modifies the gaseous phase
20 through adsorption. It is claimed by the tobacco companies that filters can reduce "tar" and nicotine smoke yields up to 50%, with a greater removal rate for other classes of compounds (e.g., phenols). However, most of these measured reductions occur only when the cigarette is consumed on a simulator, such as a smoking machine. When consumed by an actual consumer, such as a human being, deliveries remain similar with
25 or without a filter. Further, the cellulose acetate fibers and carbon particles used in the existing cigarette filters cause further human health concern, as they may be consumed together with the nicotine aerosol.

In addition, cigarette filters may create pollution when discarded into the environment.
30 Although cellulose acetate can go through biodegradation and photodegradation, both degradation processes are relatively slow and the degradation rate of cellulose acetate may be further affected by several environmental factors such as the oxygen

concentration in the environment and the exposure to light. This variance in rate and resistance to biodegradation in many conditions is a factor in environmental damage caused by the existing cigarette filters.

- 5 There exists a need to develop a filter for use with cigarette and/or other tobacco product that ameliorates the afore-mentioned drawbacks of existing cigarette filters at least in part.

SUMMARY

- 10 According to one aspect of the disclosure, there is provided a filter element for use with a tobacco product or the like. The filter element comprises a filter body formed from one or more filter materials, and a plurality of internal channels randomly disposed inside the filter body, wherein at least one of the plurality of internal channels is interconnected to another one of the plurality of internal channels to provide a plurality
15 of aerosol paths for facilitating an aerosol flow, wherein one or more of the aerosol paths extend from a first surface of the filter body to an opposite second surface.

- In some embodiments, the filter materials can include a net material or a filler material. The filler material may include natural materials or a combination of natural and
20 synthetic material.

In some embodiments, one or more of the aerosol paths are arranged to direct heat away from the aerosol flow.

- 25 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.

- 30 In some embodiments, the one or more filter materials comprise one or more of the following materials:- cotton; jute; hemp; bamboo fibers; bamboo charcoal fibers; wool; silk; nylon; polyester fibers; polyimide fibers; polylactic acid (PLA); 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); polysiloxane or silicone; natural or synthetic rubber; paper; 5 paper yarn; paper net; cork; carbon; graphene; any combinations or derivatives thereof.

In some embodiments, the one or more filter materials are formed from one or more natural materials.

10 In some embodiments, the one or more natural materials are obtained from one or more of the following plant parts: - leaf, bark, trunk, fruit, seed, stem, flower, pollen, branch, root, sap, pulp, resin bagasse, calyx of the respective flora.

In some embodiments, the filter element comprises a secondary filter material.

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In some embodiments, the secondary filter material is configured in one or more of the following forms:- crushed or powder form, granule or pellet form, filament form, strip form, fibers or hardened fibers of any shape, threads, yarns, braided ropes, and flakes.

20 In some embodiments, the secondary filter material comprises cellulose acetate (CA).

In some embodiments, the secondary filter material comprises a sliced material.

25 In some embodiments, the filter element is used in combination with one or more of the following types filters: - natural or aroma material filter, fibrous tow filter, film filter, foil filter, mesh filter, fabric filter, fabric mesh filter, sheet filter, filament filter, spongy filter, laminated filter, wafer filter, honey-comb structure filter, extruded or moulded filter, paper filter.

30 Other aspects of the disclosure will be apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the disclosure 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:

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Figure 1 illustrates a cross-sectional view of a filter element according to one embodiment and a tobacco product comprising the filter element;

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Figure 2a illustrates a net structure of a filter element 10 according to one embodiment and a filtration effect of the filter element; Figure 2b illustrates a filter element 10 formed using filler material;

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Figure 3 illustrates a cross-sectional view of a tobacco product comprising a filter element according to another embodiment;

Figure 4 illustrates a cross-sectional view of a tobacco product comprising a filter element according to another embodiment;

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Figure 5 illustrates a cross-sectional view of a tobacco product comprising a filter element according to other embodiments.

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 the disclosure.

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DETAILED DESCRIPTION

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Particular embodiments are described with reference to the accompany drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present disclosure. Other definitions for selected terms used herein may be found within the detailed description of the disclosure 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 disclosure belongs. Where possible, the same reference numerals are used throughout the figures for clarity and consistency.

5 Throughout the specification, unless the context requires otherwise, the term “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.

10 Throughout the specification, unless the context requires otherwise, the term “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.

15 Throughout the specification, unless the context requires otherwise, the term “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.

20 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.

25 Throughout the specification, unless the context requires otherwise, the term “tobacco product” includes, but is not limited to smoked tobacco products such as traditional cigarette(s) and cigar(s), heated tobacco product(s), electronic smoking device(s) such as electronic cigarette(s) and vaporizer(s)/vaping device(s).

30 Throughout the specification, the term “fiber” “filament” “string” “strip” “will be understood to depict a slender and substantially elongated shape.

Throughout the specification, the term “sheet” “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 “homogenous”, “even”, “uniform” may be construed to depict a material including parts all of the same or substantially similar structure and characteristics, an arrangement of or a process involving multiple substances or components with little variation in form, manner or degree.

10 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.

15 Throughout the specification, the term “paper”, “paper material” is used to describe a material a material formed from a pulp containing cellulose fibers. Wood, rags, grasses and part of the plants or natural resources herein described such as straw, sugarcane bagasse, bamboo, flax, hemp, and jute may be a suitable source of cellulose fibers for forming the paper material.

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In accordance to one embodiment of the disclosure and with reference to Figure 1, there is provided a filter element 10 for use with a tobacco product 100. The tobacco product 100 may also be referred to as a tobacco stick or a cigarette stick 100.

25 The filter element 10 comprises a filter body 12 formed from one or more filter materials. It is appreciable that the filter body 12 may take any suitable shape and dimension according to various designs of the tobacco product 100. One non-limiting example of the filter body 12 can be formed into a cylindrical or a rod-like shape, and can be formed from a net material and/or a filler material, as shown in Figure 1. The
30 filter body 12 may comprise a first surface 12a and a second surface 12b. As shown in Figure 1, the first and second surfaces 12a, 12b of the filter body 12 may be substantially flat.

In various embodiments, the one or more filter materials may be a material comprising an interlaced structure of fibers, threads, wires, yarns and/or filaments with a plurality of mesh openings. The filter material with the plurality of mesh openings is also referred to as a net material. In various embodiments, the net material may have various mesh shapes, sizes, width, length and diameter according to requirements. For example, the net material may be configured in the form of a tubular net. The tubular net may comprise one or more mesh openings. Each mesh opening may be formed with a particular shape, such as, but not limited to, a square shape.

In some embodiments, the net material may be a plastic netting formed using a plastic extrusion process. In some embodiments, the net material may comprise an open-meshed fabric material twisted, knotted, or woven together at pre-determined intervals. Different weaving, knitting, braiding processes may be used to form the net material of a desirable shape and dimension and with a desirable mesh size and pattern.

In various embodiments, suitable filter materials for forming the filter element 10 may comprise or be formed from the following materials (which may be plastic or non-plastic): polylactic acid (PLA), 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), 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 other materials in this list; other polymer resins, 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, possible combinations of one or more of the above materials.

In some embodiments, the filter element 10 can be made initially from one or more base fibers. The base fibers can be woven, braided, shaped or processed in other ways into the net material. For example, an animal fiber such as silk can be processed into threads,
5 and then woven or braided into the net material for forming a filter element 10.

In some embodiments, the filter material for forming the filter body 12 of the filter element 10 may comprise or may be formed from one or more natural materials obtained from various parts of different types of plants including, but not limited to, a
10 leaf, bark, trunk, fruit, seed, stem, flower, pollen, branch, root, sap, pulp, resin bagasse, calyx of the respective plants.

In various embodiments, the filter materials for forming the filter body 12 of the filter element 10 can be formed from one or more of the following natural materials
15 including, but not limited to, oak, maple, *Pandanus amaryllifolius* or screwpine, Daun Asam or tamarind, Roselle, sugarcane, lotus, Yucca, bamboo, reed, nypa fruticans, canna, mesquite, hickory, alder, *Tetrapanax papyrifer* or rice-paper plant or, Broussonetia papyrifera or paper mulberry, and any other plants, grasses, or flora; vegetables and fruits such as lemon, banana, grape, grapefruit, melon, pineapple,
20 pomegranate, cucumber, durian, orange, cherry, apple, pear, mango, apricot, peach, any edible berry, fig, pumpkin, and nectarine; edible mushroom; lichen; coconut; coir; corn; corn husk; rice; glutinous rice; hazelnut; walnut; almond; peanut; pecan; any derivatives from the above natural resources. *Pandanus amaryllifolius* or screwpine is also referred to as Rampe. It is appreciable that the natural materials may be obtained from other
25 suitable natural resources.

In various embodiments, the one or more filter materials may include a filler material. Such filler material may be formed from natural material, synthetic material or a combination of the same. It is appreciable that the list of natural material or synthetic
30 material may include those which has been described for the net filter material above.

In various embodiments, the filler material may be configured in any suitable forms for filling the volume and structure of the filter element 10, such that the plurality of randomly disposed and interconnected internal channels may be formed in the resultant filter element 20. For example, the filler material may be granule or pellet form,
5 filament form, strip form, fibers or hardened fibers of any shape, and/or flakes.

The filler or natural materials may undergo a preparatory treatment such as drying, steaming, curing, expanding, flattening, pre-cutting, heating, and carding. The pre-treated natural materials may then undergo further processes to be formed directly into
10 the filter element 10 or formed into an intermediate material (for example, a thread, a fabric material and etc.) for forming the filter element 10.

In some embodiments, the filter elements 10 comprise one or more natural flavours derived or extracted from any suitable herbs, spices, any fragrant plants, and any
15 aromatic food substances present in the natural material. The natural flavours may be derived from one or more of the following: vanilla, chamomile, cinnamon, mint, abaca, hemp, cardamom, doringin or tarap tree leaf, tea, Rampe or *Pandanus amaryllifolius* or screwpine, coffee bean, cacao bean, butter, honey, ginger. For example, extracts distilled from or otherwise extracted from the leaves or flowers of screwpine plants may
20 be used to add a sweet aroma to the filter elements 10. The extract obtained from the flowers of screwpine plants is also known as Kewra.

In some embodiments, the filter material for forming the filter body 12 of the filter element 10 may comprise natural materials obtained from one or more herbs, spices,
25 flowers or flowering plants including, but not limited to, Aconitum, African Daisy, Agapanthus, Alchemilla, Allium roseum, Albizia, Alstroemeria, Alyssum, Amaranthus, Amaryllis, Anemone, Angelonia, Anthurium, Aquilegia, Argeratum, Aster, Astilbe, Astrantia, Aubretia, Azalea, Baby's Breath, Bachelor's Button, Balloon Flower, Bee Balm Flower, Begonia, Bellflower, Bergenia, Black-Eyed Susan, Blanket Flower,
30 Blazing Star, Bleeding Heart, Blue Star Flower, Bluebell, Blue-Eyed Grass, Bouvardia, Buddleja, Bush Morning Glory, Buttercup, Calendula officinalis, California Poppy, Calla Lily, Candytuft, Canna Lily, Cape Primrose, Cardinal Flower, Carnation, Celosia,

Chrysanthemum, Clarkia, Clematis, Clove, Clover, Cockscomb, Columbine,
 Coneflower, Coral Bells, Coreopsis, Cosmos, Cotoneaster, Cranesbill Geranium,
 Creeping Phlox, Crocosmia, Crocus, Crown Imperial, Cuckoo Flower, Cyclamen,
 Daffodil, Dahlia, Daisy, Daphne, Day Lily, Delphinium, Desert Rose, Dianella,
 5 Dianthus, Diascia, Dichondra, Dietes, Dutch Iris, Echium, English Bluebell, Erica,
 Erigeron, Eustoma, Evening Primrose, Everlasting Daisy, Flannel Flower, Flax Flower
 or Linseed, Floss Flower, Forget Me Not, Forsythia, Foxglove, Frangipani or Plumeria,
 Freesia, French Marigold, Fuschia, Gaillardia or Blanket Flower, Gardenia, Gaura,
 Geranium, Gerbera, Giant Bellflower, Gladiolus, Goldenrod, Grape Hyacinth,
 10 Heartsease, Heather, Hebe or Showy Speedwell, Helenium, Heliotrope, Hellebore,
 Hibiscus, Hollyhock, Honesty, Honeysuckle, Hosta, Hyacinth, Hydrangea, Hypericum,
 Ice Plant, Iceland Poppy, Ilex, Impatiens, Iris, Ixia, Ixora, Jaborosa, Jacob's Ladder,
 Jasmine, Jonquil, Kaffir Lily, Kalmia, Kangaroo Paw, Knautia macedonica, Kniphofia,
 Kolkwitzia, Lady's Slipper, Lantana, Lavender, Lechenaultia, Lilac, Lily of the Valley,
 15 Lily, Linaria, Lisianthus, Lobelia, Lotus, Love in the Mist, Lunaria, Lupin, Magnolia,
 Mallow, Maltese Cross, Mandevilla, Marguerite Daisy, Marigold, Matthiola,
 Mayflower, Meconopsis, Mexican Fireplant, Milkweed, Mimosa, Mina lobata, Monk's
 Hood, Moonflower, Morning Glory, Muscari, Narcissus, Nasturtiums, Nemesia,
 Nemophila, Nepeta, Nerine, Nierembergia, Nigella, Nolana, Orchid, Oriental Lily,
 20 Oriental Poppy, Ornamental Onion, Osteospermum, Osmanthus, Ox Eye Daisy, Oyster
 Plant, Painted Daisy, Pansy or Violet Tricolor, Passion Flower, Peace Lily, Pelargonium,
 Penstemon, Peony, Persian Buttercup, Peruvian Lily, Petunia, Phlox, Pincushion
 Flower, Pink Lady's Slipper, Plume Celosia, Pointsettia, Polyanthus, Poppy Anemone,
 Portulaca grandiflora, Pot Marigold, Powder Puff, Primula, Purple Coneflower, Quaker
 25 Ladies, Queen Anne's Lace, Queen of the Meadow, Queen's Cup, Quince, Rain Lily,
 Ranunculus, Rock Rose, Redbud, Rondeletia, Rose of Sharon or shrub althea, Rose,
 Rhododendron, Rudbeckia, Salvia splendens, Saponaria, Scabiosa, Scaevola, Scented
 Geranium, Scilla, Sedum, Shasta Daisy, Silene, Snapdragon, Snowdrop, Snowflake,
 Speedwell, Starflower, Statice, Strawflower, Sun Drop, Sunflower, Sweet Pea, Syringa,
 30 Tea Rose or hybrid tea rose, Tiger Flower, Tiger Lily, Tithonia, Trachelium, Trillium,
 Triplet Lily, Tritonia crocata, Trollius, Tropaeolum, Trumpet Vine or Hummingbird
 Vine, Tuberose, Fever Root, Snapdragon Root, Tulip, Urn Plant, Ursinia, Uva Ursi,

Verbena, Veronica incana, Viburnum, Vinca Minor, Viola wittrockiana, Viola, Violet, Virginia Creeper, Wallflower or Erysimum, Wandflower, Water Lily, Watsonia, Wax Plant or porcelainflower, Wedelia, Weigela, Whirling Butterflies, Wild Rose or Rosa acicularis, Wild Violet, Windflower, Winter Aconite, Winter Jasmine, 5 Winterberry, Wishbone Flower, Wisteria, Woolly Violet, Xerophyllum, Xylobium, Xylosma, Xyris difformis, Yarrow, Yellow Archangel, Yellow Bell, Yellow-Eyed Grass, Yellowhorn, Zenobia, Zephyranthes, Zinnia.

10 In some embodiments, the filter element 10 comprises sugarcane bagasse. The sugarcane bagasse can be formed into the filter element 10, for example by weaving, knitting or braiding sugarcane bagasse fibers into the filter element 10, with a net structure or into a net material for forming the filter element 10. Alternatively and/or additionally, the sugarcane bagasse can be incorporated into the filter element 10 to enhance filtration effect.

15 Advantageously, the natural materials used as filler material for forming the filter body 12 may impart a natural organic taste, aroma, flavour or smell onto the tobacco product 100, and onto the smoke or aerosol generated by the tobacco product 20 for user inhalation. Since the above materials are derived from natural sources, the filter element 20 10 made from the above natural materials is typically biodegradable and therefore may be environmentally friendly.

In some embodiments, the filter material 14 for forming the filter body 12 of the filter element 10 may be formed from a paper material. In some embodiments, the paper 25 material may be first processed into a paper yarn through various slicing and spinning processes. Thereafter, the paper yarn may be woven or braided to form the filter element 10 with a net structure. It is appreciable that a paper material may be in any shapes and forms suitable for use in a subsequent braiding or weaving process for the net material. For example, the paper material may be in the form of ribbon-like paper strips, and 30 laced or unlaced paper rope or paper cords.

In some embodiments, the paper yarn, paper strip, paper rope or paper cord may also be woven or braided into a paper net as an intermediate material for forming the filter body 10. The woven or braided paper net may be substantially planar, or may be in any other suitable shapes and forms. The filter element 10 formed by weaving or braiding a paper material is also referred to as a woven or braided paper filter.

In some embodiments, the paper filter may be imparted with a natural flavour. The flavour may be imparted from the above-described natural materials in the formation of the paper filter or in the coating of the paper filter.

In various embodiments, the filter element 10 may comprise or may be formed from food grade non-toxic materials suitable as the filter element in a tobacco product.

It is appreciable that the filter element 10 may be formed from or may comprise any suitable materials, or combinations of different materials as herein described. Further, a tobacco product 100 may comprise one or more filter elements 10 formed from the same or from different materials.

In various embodiments, the filter element 10 may be placed at the downstream of a tobacco unit 110 of the tobacco product 100 for filtering a smoke or aerosol produced from the tobacco unit 110. In some embodiments, the filter element 10 may be integrated in the tobacco product 100 during the manufacturing process. In some embodiments, the tobacco product 100 may be coupled to the filter element 10, or mounted onto a device or a filter assembly comprising the filter element 10.

In various embodiments, the tobacco unit 110 comprises a tobacco material as its major constituent, which produces a tobacco smoke or aerosol when ignited or heated. The tobacco material includes, but are not limited to, cured/dried tobacco leaves/stems and reconstituted tobacco materials in any form. The tobacco material may comprise other additives such as non-tobacco fibers, humectants, plasticisers, flavourants, fillers, aqueous and non-aqueous solvents and any combinations thereof. In some

embodiments, the tobacco unit 110 may further comprise one or more aerosol-formers, such that it releases a tobacco-flavoured vapor or aerosol when heated.

In various embodiments, the filter element 10 may be placed inside the tobacco product 100 and may be arranged coaxially with the tobacco unit 110 along a longitudinal axis of the tobacco product 100. For example, the tobacco unit 110 and the filter elements 10 may be arranged in a cylindrical form. The cylindrical tobacco unit 110 and the cylindrical filter elements 10 may be aligned along a common axis and may adjoin each other at the base surfaces so as to assemble into the tobacco product 100.

In some embodiments as shown in Figure 1, the tobacco unit 110 may be placed at a first end 100a of the tobacco product 100 at the extreme upstream, and the filter element 10 may adjoin the tobacco unit 110 at the first surface 12a. The first surface 12a functions as an interface between the tobacco unit 110 and filter element 10.

In some embodiments, the filter element 10 may not be adjacent to the tobacco unit 110. In other words, the filter element 10 may not be at the immediate downstream of the tobacco unit 110, and may be placed adjacent to other components of the tobacco product 100. Non-limiting examples of the placement of the filter element 10 with respect to other components of the tobacco product 100 are shown in Figure 4. In some embodiments, a tubular element 43 may be placed adjacent and at the upstream of the filter element 10. In some embodiments, another filter of a different type 38, for example, a tow filter, may be placed adjacent and/or at downstream of the filter element. It is appreciable that the filter element 10, when used in combination with other types of filters 38 and/or other components such as the tubular element 43, may be arranged in different configurations to form a tobacco product 100 with a desirable mechanical and thermal property.

When ignited or heated, the upstream tobacco unit 110 produces a tobacco-flavoured smoke or aerosol. The one or more filter elements 10 in the tobacco product 100 are configured to facilitate the flow of the aerosol from the tobacco unit at the first end 110a through the tobacco product 100, and ultimately to a second end 110b of the tobacco

product to be inhaled by the user. The second end 110b, which is at the extreme downstream of the tobacco product 100 and which, in use, is held to the mouth of a user, is also referred to as a mouth-end 110b. As shown in Figure 2a and 2b, a stream 24 of the smoke or aerosol produced from the tobacco unit 110 is drawn through the filter element 10 as a user puffs at a mouth-end 100b of the tobacco product 100. While passing through the filter element 10, volatile and harmful substances (for example, specific constituents of particulate phase including tar particles and tobacco dusts, and volatile substances with a relatively large molecule size and weight) within the aerosol stream may be reduced or removed through various filtration mechanisms such as adsorption and absorption.

In various embodiments, the filter element 10 comprises a plurality of internal channels. In relation to embodiments including net filter materials, the internal channels of the filter element 10 may be formed as a consequence of the net structure arising from the mesh openings of the net material during the process of forming the filter body 12 from the net material. In relation to embodiments including filler material, the internal channels may be formed from an arrangement of randomized filling with natural and/or synthetic filter materials. In relation to embodiments including combinations of the net filter materials and filler materials, the internal channels may be as a consequence of either the net filter structure or the randomized configuration of the filler material. It is to be appreciated that the internal channels may also be formed via a combination of the net filter structure and the randomized arrangement of the filling material.

Inside the filter body 12, the internal channels are randomly disposed or randomized. In other words, each of the plurality of internal channels of the filter element 10 may be arranged to begin and/or terminate at different locations inside the filter body 12, and/or may be oriented along different directions. Further, due to the interlaced structure of the net material and/or due to the randomized filling with the filler materials, the internal channels formed inside the filter element 10 may also be interconnected. The filter element 10 with the randomly disposed and interconnected internal channels facilitates the tobacco-flavoured smoke or aerosol generated by heating/combusting the tobacco unit 110 to flow through the filter element 10, and towards the direction of the

mouth-end 100b of the tobacco product 100. The tobacco-flavoured smoke or aerosol flowing through the filter element 10 of the tobacco product 100 is also referred to as a smoke or aerosol stream 24.

5 Reference is made to Figure 2a and 2b, which illustrates how smoke or aerosol stream travels through the filter element 10 and the particle retention/filtration effect provided by the filter element 10. In use, the first surface 12a of the filter element 10, which is adjacent the tobacco unit 110 or adjacent other upstream components of the tobacco product 100, functions as an interface to receive vaporized tobacco after heat is applied
10 to the tobacco unit 110. One or more internal channels that begin or have one end disposed at the first surface 12a of the filter body 12 may allow the smoke or aerosol stream 24 from the upstream components to enter the filter element 10. The randomly disposed and interconnected internal channels may form or may provide for a plurality of paths 27 for the smoke or aerosol stream to travel inside the filter body. Some of
15 aerosol paths 27 formed by the interconnected internal channels extend from the first surface 12a of the filter body to an opposite second surface 12b, along which the smoke or aerosol stream received at the first surface 12a travels to and exists from the second surface 12b of the filter element 10. Because the internal channels are randomly disposed inside the filter body, the smoke or aerosol stream 24 may travel along
20 different branching aerosol paths 27 once entering the filter element 10, as illustrated in Figure 2a and 2b.

In some embodiments, the filter body 12 may be shaped and dimensioned as a rod or a tube. In some embodiments, the filter body 12 of the filter element 10 may be of a
25 relatively small thickness, and may be a relatively flat structure in the form of a thin layer, a disc, or a thin sheet. The filter element 10 with a relatively small thickness and a relatively flat structure may be referred to as a flat net filter.

In some embodiments, the filter element 10 or the flat net filter may comprise one or
30 more layers formed by braiding or weaving a plurality of fibers, threads, ropes, yarns, or filaments. The flat net filter may be arranged in a similar manner as a membrane filter. The braiding or weaving process can be adapted and controlled to produce a flat

net filter with a desired property. For example, the thickness and mesh density of such flat net filter can be controlled by applying different braiding or weaving patterns and by controlling other parameters of the braiding/weaving process. In some embodiments, at least one flat net filter may be used in combination with one or more conventional
5 filters or one or more similar flat net filters, each of the flat net filter or conventional filter can be placed at different locations with respect to the tobacco unit 110 along the tobacco product 100 for an enhanced filtration effect.

Advantageously, the filter element 10, which comprises the plurality of randomized and interconnected internal channels and the plurality of aerosol paths 27 formed therefrom,
10 provides for an enhanced particle retention and filtration effect on the tobacco-flavoured smoke or aerosol generated from the upstream tobacco unit 110. As the smoke or aerosol stream is drawn through the filter element 10, particulate elements 25 in the aerosol which may give rise to undesirable taste can be filtered or blocked by the randomized internal channels therein, as shown in Figure 2a and 2b. At the same time,
15 water vapour molecules with a relatively smaller molecule size are allowed to pass through the filter element 10. This is different from the conventional cigarette filters, for example acetate tow filters, where the particulate elements in the aerosol can pass through relatively unhindered. Although the filter element 10 may be arranged to block or filter particulate elements, the filter element 10 does not filter vapor associated with
20 or containing the tobacco flavour. The filter element 10 therefore provides the additional benefits of reducing the amount of particulate elements in the tobacco smoke or aerosol without affecting the tobacco taste of the smoke or aerosol. In this manner, the level of harmful substances in the aerosol can be effectively controlled and the tobacco-flavoured aerosol delivered to the user for consumption is improved.
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Further, the filter element 10 provides a better aerosol delivery, in particular with a relatively lower pressure drop across the tobacco product 100. While aerosol is directed to flow through the filter element 10, the filter element 10 with the randomly disposed
30 internal channels and the aerosol paths 27 formed therefrom also helps redirect or distribute heat from the aerosol across the filter element 10. More specifically, the randomly disposed internal channels can form a multitude of branching aerosol paths

27 along which aerosol may travel. As described above, some of the aerosol paths 27 may connect two ends of the filter body 12, i.e. the first and second surfaces 12a, 12b, which allow the smoke or aerosol stream generated from the upstream tobacco unit 110 to be drawn through the filter element 10, and towards the mouth-end 100b of the tobacco product 100 for inhalation. Some of the branching aerosol paths 27 may terminate inside the filter element 10 and may not connect to either end of the filter element 10. These paths act as a heat sink, to transmit and redistribute heat away from the smoke or aerosol stream as it passes through the filter element 10. The tobacco product 20, when incorporated with the filter element 10, may provide for a desirable mouthfeel and improved user experience.

In various embodiments, the filter element 10 may further comprise a secondary filter material in any suitable form including, but not limited to, another filler material from natural or aromatic materials, crushed or powder form, granule or pellet form, filament form, strip form, fibers or hardened fibers of any shape, yarns, braided ropes, and flakes. For example, a quantity of the secondary filter material in the form of granules or pellets may be encased in a specifically made container formed from one or more net materials. In other words, the filter element 10 or net filter 10 may comprise a hollow portion or a cavity for containing a secondary filter material in the form of granules or pellets. The filter element 10 comprising a secondary filter material encased therein is also referred to a granule-filled filter.

In various embodiments, the secondary filter material may be formed from any of the following materials:- plastic materials including, but not limited to, polylactic acid (PLA), polyethylene (PE), polyethylene terephthalate (PET), polyethylene ether ketones (PEEK), polypropylene (PP), polytetrafluoroethylene (PTFE) such as Teflon™, polyvinylchloride (PVC), other 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 other materials in this list, and all other suitable plastic materials and plastic derivatives; carbon, graphene, fiberglass; any combinations or

derivatives thereof. It is appreciable that the filter element 10 may comprise any suitable secondary filter materials, not limiting to the materials listed herein.

5 In some embodiments, the filter element 10 may comprise a secondary filter material formed from cellulose acetate (CA). The secondary filter material may comprise cellulose acetate (CA) in one or more of the following forms:- crushed or powder form, granule or pellet form, filament form, strip form, fibers or hardened fibers of any shape, threads, yarns, braided ropes, and flakes.

10 In some embodiments, the filter element 10 may comprise a charcoal material or may include certain amount of carbon compound as a secondary filter material. The carbon compound may be an active carbon component which can include a highly porous structure to provide for improved filtration and adsorption efficiency.

15 In some embodiments, the filter element 10 may further comprise one or more additive materials capable of altering the volatile or semi-volatile constituents in the smoke or aerosol stream through chemical reaction.

20 It is appreciable that the tobacco product 100 may comprise one or more of the filter elements 10 as described. The tobacco product 100 may be placed at different locations with respect to the tobacco unit 110 and other components of the tobacco product 100.

25 In some embodiments, the filter element 10 may comprise 10% to 90% of the total length of the product 100. The length of the tobacco product 100, and/or the length of the components of the tobacco products 100, refer to a distance or dimension measured along a longitudinal axis of the tobacco product from one end to another end of the tobacco product 100 and/or of the components of the tobacco product 100.

30 In some embodiments, the length of the tobacco product 100 comprising the tobacco unit 110, the filter elements 10 and other components may be in the range between 15mm up to 130mm and above.

In some embodiments, the length of the filter element 10 may be in the range between 10 mm up to 40 mm and above.

5 In some embodiments, the diameter of the filter element 10 may be in the range between 4 mm up to 10 mm and above.

10 In various embodiments, the filter element 10 as herein describe may be used in combination with one or more other types of filters including, but not limited to the following: - a fibrous tow filter, film filter, foil filter, mesh filter, fabric filter, fabric mesh filter, sheet filter, filament filter, spongy filter, laminated filter, wafer filter, honey-comb structure filter, extruded or moulded filter, paper filter, and any combinations and derivatives thereof.

15 In various embodiments, the filter element 10 may be used in combination with one or more filters which are formed from or comprise one or more filter materials that are sliced or shredded or cut. For example, the sliced or cut materials can be rolled up with wrinkled paper to form into a rod-like shape or other suitable shapes for incorporation into the tobacco product 100. The filter formed from the sliced or cut material may be placed at any part of the tobacco product 100. For example, the filter formed from the
20 sliced or cut materials may be placed downstream of the filter element 10, and/or at the mouth-end 100b of the tobacco product 100.

In some embodiments, the sliced or cut material may be incorporated into the filter element 10 as a secondary filter material.

25

In various embodiments, the sliced or cut material may be in any suitable form including, but not limited to, slices of I-shape or straight cut, H-shape, N shape, Z-shape or zig-zag, s-shape, curves or waves, arc shape or any non-linear and non-symmetrical, or any random cuts. The sliced or cut material can be formed using any suitable cutting
30 process, for example, using a die cut process. The sliced or cut materials may be folded or processed in other way to provide a corrugated surface texture. The sliced or cut paper material are light in weight. When used in combination with, or incorporated into

the filter element 10, the sliced or cut material provides an improved filtration effect because the aerosol paths or channels within the filter element 10 are randomized due to the random cutting shapes of the individual slices and the surface textures of the sliced materials.

5

In some embodiment, a hybrid filter 40 may be formed by combining the filter element 10 and other types of filters to form one single unit. For example, the filter element 10 with the net structure or any filler material from natural materials (i.e. flowers) may be incorporated into a hollow part of a conventional tow filter 38 or other types of filter, as illustrated in Figure 3. This hybrid filter 40 advantageously combines functionality of the filter element 10 and other types of filters in one single unit.

10 In some embodiments, the filter element 10 may only take up or occupy only part of the hollow portion, as shown in Figure 5. The filter element 10 may be placed at any part of the hollow portion, for example, near the tobacco unit 110, in the middle of hollow portion or near the mouth-end 100b of the tobacco product. The pressure drop or resistance across the hybrid filter 40 is relatively low, because only part of the hollow portion is filled or occupied by the filter element 10. Also, as the smoke or aerosol generated from the tobacco unit 110 is directed to pass through the filter element 10 inside the hollow portion of the hybrid filter 40, the same or a comparable filtration effect can be achieved in this hybrid filter 40 despite less filter material used. Further, material costs of making the filter element 10 can be reduced.

20 In some embodiments, a conventional tow filter 38 may be used to supplement the filter element 10. For example, the tow filter 38 may be placed downstream of the filter element 10, downstream the hybrid filter 40, and/or at the mouth-end 100b of the tobacco product 100 as illustrated in Figure 4.

25 It is appreciable that the filter element 10 as described may be adapted for use with traditional tobacco products such as a cigarette stick, and/or a heatable tobacco product. For example, the filter element 10 with a relatively lower mesh density and correspondingly a relatively lower draw resistance may be more suitable for use with a traditional tobacco products which requires a relatively lower draw resistance in the

cigarette rod as compared to heatable tobacco product to facilitate burning or combustion of the tobacco material. In some embodiments, the filter element 10 may be adapted for use with a product containing smokable herbs and other nicotine-free tobacco substitutes. Further, net materials and secondary filter materials for forming the
5 filter element 10 which can withstand a relatively higher temperature without degradation or deformation may be more suitable for forming filter elements which are intended to be used in the traditional cigarette products.

The process of forming the filter element 10 may include a step of gathering one or
10 more filter materials, and a further step of forming the gathered filter materials into a filter element of a desired size and dimension.

In some embodiments, the one or more filter materials may be gathered into one or more elongate filter strands, which are then fed into a forming machine. As the one or
15 more filter materials passes through the forming machine, the filter materials may be compressed into a desired dimension, such as a diameter, and/or formed into a rod-like filter element or a continuous elongate filter body for further processing into the filter element 10. In relation to embodiments including net filter materials, the flexibility of the net material may allow it to better conform to the shape of the inner channel of the
20 tubular forming element, with minimal manufacturing variation.

In some embodiments, a mechanical force may be applied to stretch the one or more filter materials into an elongate filter strand. The elongate filter strand may then be fed into the forming machine.
25

In some embodiments, heat may be applied to the one or more filter materials as they pass through the forming machine. The one or more net materials may transition or change from a hard and glassy state to a relatively soft and rubbery state.

30 The resultant filter element 10 has an integral and relatively uniform net or porous structure. A non-limiting example of the net structure of the filter element 10 is shown in Figure 2a and Figure 2b. The porosity of the 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 shape and dimension of the filler material, the compression ratio, and other process parameters (e.g. the feeding speed, the mechanical force applied to stretch the net materials, and the heat applied to the net materials etc.). A wide range of materials may be selected for forming the filter element 10 with different properties, for example, with different weight, with a higher or lower temperature resistance and etc. Depending on the system requirements, the process can be adapted and controlled to produce a filter element 10 with a desired property. For example, when heat is applied to the net materials, two or more of the mesh openings of starting net materials may fuse or combine to form a plurality of internal channels of different sizes and shapes in the resultant filter element 10. In this manner, a relatively more randomized and relatively less ordered net structure of the filter element 10 may be formed.

It is appreciable that other suitable techniques may be used to form the filter element 10 from the one or more filter materials for example, by rolling the one or more net materials into a rod-like filter element or a continuous elongate filter body for further processing into the filter element 10, or by weaving or braiding one or more fibers or filaments or yarns directly into the filter element 10 with desired shape and dimension.

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

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
	12	filter body
5	12a	first surface
	12b	second surface
	24	smoke or aerosol flow/stream
	25	particulate element
	27	aerosol path
10	38	tow filter or other types of filters
	40	hybrid filter
	43	tubular element
	100	tobacco product
	100a	first end
15	100b	second end or mouth-end
	110	tobacco unit

CLAIMS

1. A filter element for use with a tobacco product or the like comprising: -

- 5 a filter body formed from one or more filter materials, and
 a plurality of internal channels randomly disposed inside the filter body,

wherein at least one of the plurality of internal channels is interconnected to another one of the plurality of internal channels to provide a plurality of aerosol paths for facilitating an aerosol flow,

- 10 wherein one or more of the aerosol paths extend from a first surface of the filter body to an opposite second surface.

2. The filter element according to claim 1, wherein the filter material is formed from at least one of a net material, a filler material, and a combination of a net and a filler material.

- 15 3. The filter element according to claim 1 or 2, wherein one or more of the aerosol paths are arranged to direct heat away from the aerosol flow.

- 20 4. The filter element according to any one of the preceding claims, 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.

- 25 5. The filter element according to any one of the preceding claims, wherein the one or more filter materials comprise one or more of the following materials:- cotton; jute; hemp; bamboo fibers; bamboo charcoal fibers; wool; silk; nylon; polyester fibers; polyimide fibers; polylactic acid (PLA); polyethylene (PE); polyethylene terephthalate (PET); polyethylene ether ketones (PEEK); polypropylene (PP); polytetrafluoroethylene (PTFE); polyvinylchloride (PVC); cellulose acetate (CA),
30 starch based polymers, liquid crystal polymer material (LCP); polyacrylonitrile (PAN);

polysiloxane or silicone; natural or synthetic rubber; paper; paper yarn; paper net; cork; carbon; graphene; any combinations or derivatives thereof.

5 6. The filter element according to any one of the preceding claims, wherein the one or more filter materials are formed from one or more natural materials.

10 7. The filter element according to claim 6, wherein the one or more natural materials are obtained from one or more of the following plant parts: - leaf, bark, trunk, fruit, seed, stem, flower, pollen, branch, root, sap, pulp, resin bagasse, calyx of the respective flora.

8. The filter element according to any one of the preceding claims, wherein the filter element comprises a secondary filter material.

15 9. The filter element according to claim 8, wherein the secondary filter material is configured in one or more of the following forms:- another natural or synthetic filler material, crushed or powder form, granule or pellet form, filament form, strip form, fibers or hardened fibers of any shape, threads, yarns, braided ropes, and flakes.

20 10. The filter element according to claim 8 or 9, wherein the secondary filter material comprises cellulose acetate (CA).

25 11. The filter element according to any one of claims 8 to 10, wherein the secondary filter material comprises a sliced material.

30 12. The filter element according to any one of the preceding claims, wherein the filter element is used in combination with one or more of the following types of filters: - filters formed from one or more natural or synthetic filler materials, fibrous tow filter, film filter, foil filter, mesh filter, fabric filter, fabric mesh filter, sheet filter, filament filter, spongy filter, laminated filter, wafer filter, honey-comb structure filter, extruded or moulded filter, paper filter.