

DEGRADABLE FILTER FOR SMOKING ARTICLES

The present invention relates to a filter for a smoking article, the filter comprising a segment of filtration material comprising regenerated cellulose fibres, cellulose acetate fibers, and triacetin. The present invention also relates to a filter for a smoking article, the filter comprising a segment of filtration material comprising regenerated cellulose fibers and a low molecular weight polyether. The present invention also extends to smoking articles comprising such filters.

Filter cigarettes typically comprise a cylindrical rod of tobacco cut filler surrounded by a paper wrapper and a cylindrical filter axially aligned in an abutting end-to-end relationship with the wrapped tobacco rod. The cylindrical filter typically comprises a filtration material, usually cellulose acetate tow, circumscribed by a paper plug wrap. Conventionally, the wrapped tobacco rod and the filter are joined by a band of tipping wrapper, normally formed of an opaque paper material, which circumscribes the entire length of the filter and an adjacent portion of the wrapped tobacco rod.

A number of smoking articles in which tobacco is heated rather than combusted have also been proposed in the art. In heated smoking articles, an aerosol is generated by heating a flavour generating substrate, such as tobacco. Known heated smoking articles include, for example, electrically heated smoking articles and smoking articles in which an aerosol is generated by the transfer of heat from a combustible fuel element or heat source to a physically separate aerosol forming material. During smoking, volatile compounds are released from the aerosol forming substrate by heat transfer from the fuel element and entrained in air drawn through the smoking article. As the released compounds cool they condense to form an aerosol that is inhaled by the consumer. Smoking articles in which a nicotine-containing aerosol is generated from a tobacco material, tobacco extract or other nicotine source, without combustion or heating, are also known.

After a smoking article has been smoked and the remainder of the article has been discarded, it is desirable that the filter section degrade as quickly as possible. It would be desirable to provide a filter for a smoking article which facilitates this.

According to a first aspect of the present invention, there is provided a filter for a smoking article, the filter comprising a segment of filtration material, wherein the filtration material comprises randomly oriented regenerated cellulose fibres and cellulose acetate fibers. The filtration material further comprises triacetin, and the filter also includes a wrapper circumscribing the segment of filtration material.

The term "regenerated cellulose fibres" is used herein to mean cellulose fibres which have been formed by processing a naturally occurring cellulose material to provide cellulose fibres having a desired physical property. A typical process for forming regenerated cellulose fibres includes the steps of: pulping a naturally occurring cellulose material, such as wood chips, to form a pulp; subjecting the pulp to one or more treatment steps to alter the physical properties of the cellulose; and forming fibers of regenerated cellulose from the treated pulp, for example by spinning cellulose fibres by passing the pulp through a spinneret.

Advantageously, using a filtration material that comprises randomly oriented regenerated cellulose improves the degradation of the filtration material. This is because the randomly oriented fibres can more easily disperse after the filter has been discarded, particularly when compared with the substantially continuous filaments of traditional cellulose acetate tow filters. Increased dispersion of the fibres increases the exposure of the individual fibres to the environment, thus increasing the rate at which the filtration material degrades.

Furthermore, despite using regenerated cellulose fibers in the filtration material, filters in accordance with the present invention deliver a similar taste to the consumer when compared with traditional cellulose acetate tow filters. The similar taste sensation is due to the cellulose acetate fibers and the triacetin binder present in the filtration material of filters in accordance with the present invention. Moreover, whilst the triacetin binds to the cellulose acetate fibers to improve the structural integrity of the filtration material, the triacetin does not bind to the regenerated cellulose fibers, thus maintaining the improved degradation of the filtration material.

The inventors have also recognised that filters consisting of only regenerated cellulose fibers do not exhibit the same levels of selective phenol retention during smoking of the smoking article when compared to traditional cellulose acetate filters. Therefore, filters in accordance with the present invention address this problem by incorporating cellulose acetate fibers and triacetin into the filter with the regenerated cellulose fibers.

The triacetin is preferably present in an amount of about 1% to about 15% by weight of the filtration material in the filter segment, more preferably about 5% to about 10% by weight of the filtration material in the filter segment, most preferably about 3% to about 5% by weight of the filtration material in the filter segment.

In some embodiments, the filtration material further comprises a low molecular weight polyether to further increase the ability of the filter to selectively retain phenols during smoking of the smoking article. A suitable polyether is polyethylene glycol. Preferably, the polyethylene glycol has a number average molecular weight of between about 200 and about 3600, preferably between about 400 and about 1600.

The use of a low molecular weight polyether to increase the selective phenol retention of a filtration material comprising randomly oriented regenerated cellulose fibers is itself a novel and inventive arrangement. Therefore, according to a second aspect of the present invention, there is provided a filter for a smoking article, the filter comprising a segment of filtration material, the filtration material comprising randomly oriented regenerated cellulose fibres and a low molecular weight polyether. The filter further comprises a wrapper circumscribing the segment of filtration material.

As discussed above, incorporating a low molecular weight polyether into the filtration material improves the selective phenol retention of the filtration material. This may be important where a regenerated cellulose filter is used to replace a traditional cellulose acetate tow filter, for example, since regenerated cellulose fibers exhibit less selective phenol retention when compared to traditional cellulose acetate. The use of a low molecular polyether to improve the selective phenol retention of a regenerated cellulose filter is illustrated in the examples shown in Table 1 below:

	catechol µg/mg nicotine	phenol µg/mg nicotine	m+p cresols µg/mg nicotine
Cellulose acetate with 7% triacetin	56.548	10.158	8.439
100% Lyocell	69.798	38.973	20.191
100 parts Lyocell + 5 parts PEG400	56.159	23.155	13.932

Table 1: Comparison of retention of different phenols by a traditional cellulose acetate filter, a regenerated cellulose (Lyocell) filter, and a regenerated cellulose (Lyocell) + polyethylene glycol (PEG) filter. The data represents the amount of each phenol which passes through the filter (that is, the amount of phenol not retained by the filter) when the article is smoked. The data is normalised with respect to the amount of nicotine which is also passes through the filter during smoking of the article. The data was collected using a smoking test in accordance with ISO 4387: Determination of total and nicotine-free dry particulate matter using a routine analytical smoking machine.

A suitable polyether is polyethylene glycol. Preferably, the polyethylene glycol has a number average molecular weight of between about 200 and about 3600, preferably between about 400 and about 1600.

To further improve the function of the filter to selectively remove phenols during the smoking of the smoking article, the filtration material may include triacetin. Including triacetin also helps to increase filter stiffness, which reduces the likelihood of filter collapse during

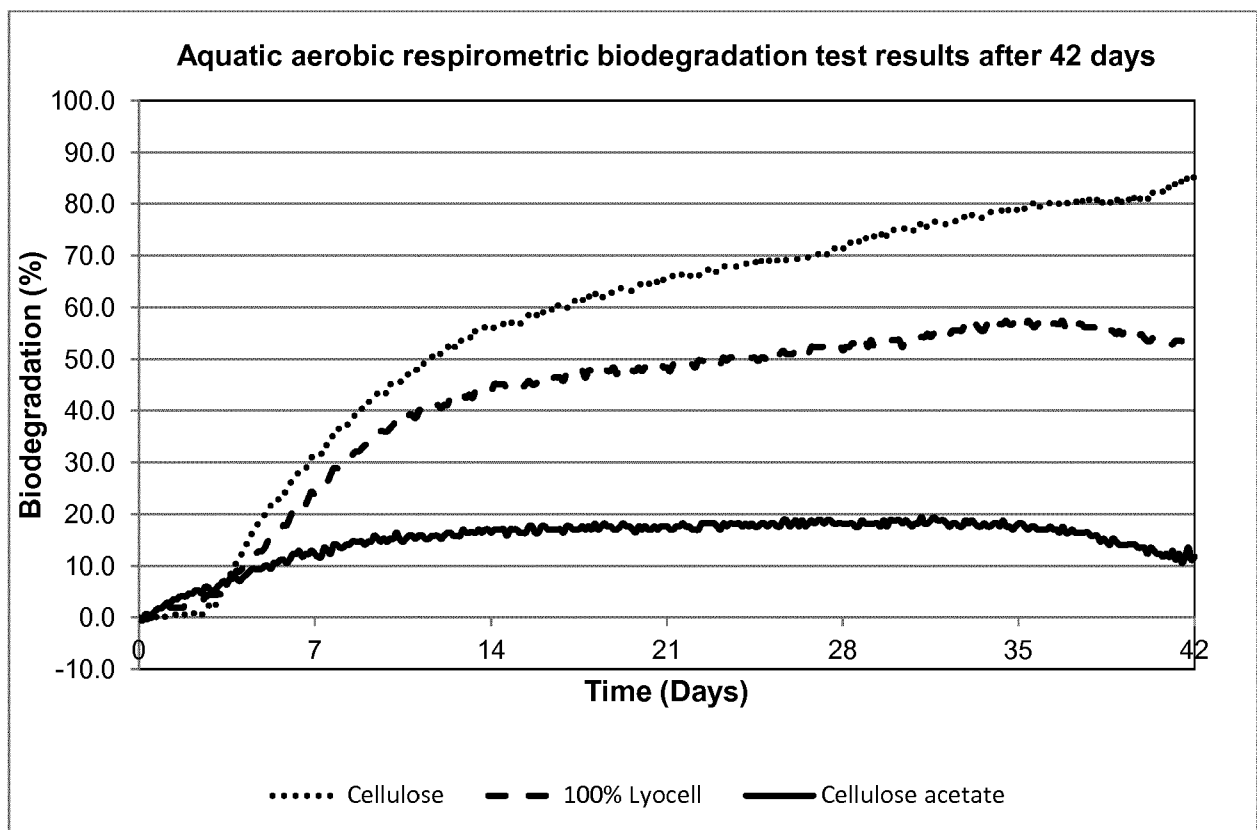
handling of the smoking article and during smoking. In embodiments comprising triacetin, the triacetin is preferably present in an amount of about 1% to about 15% by weight of the filtration material in the filter segment, more preferably about 5% to about 10% by weight of the filtration material in the filter segment, most preferably about 3% to about 5% by weight of the filtration material in the filter segment.

Preferably, filtration materials in accordance with both aspects of the present invention will degrade by at least about 30%, more preferably at least about 40%, more preferably at least about 50%, within less than about 40 days, preferably less than about 30 days, when measured in accordance with either of the following tests:

ISO 14855-2005, TEST1: aerobic biodegradation under controlled composting conditions

ISO 14851-2004, TEST2: aquatic aerobic respirometric biodegradation test

To illustrate the improved degradation of a filter including regenerate cellulose fibers when compared to a traditional cellulose acetate filter, a comparison of the degradation of different filters under ISO 14851-2004, TEST2 is shown in Graph 1 below:



Graph 1: Comparison of the degradation of various filters under the conditions of ISO 14851-2004. Test filters are 100% regenerated cellulose (Lyocell) fibres and a traditional cellulose

acetate filter. For reference, the degradation of a pure cellulose sample under the same conditions is also shown.

The random orientation of the fibres in filters according to the present invention advantageously provides the required resistance of the filtration material to mechanical deformation, such that the filter can withstand being grasped by the consumer during smoking of the smoking article. The random orientation of the fibres also provides the required resistance to draw such that the smoking experience using filters in accordance with the present invention is substantially the same as the smoking experience using a traditional cellulose acetate tow filter. Filters in accordance with both aspects of the present invention may have a resistance to draw of between about 40 mm WG and about 250 mm WG for a filter length of 27 millimetres, preferably from about 75 mm WG to about 175 mm WG for a filter length of 27 millimetres, and most preferably from about 100 mm WG to about 150 mm WG for a filter length of 27 millimetres. Resistance to draw is measured using the test procedure described in ISO 6565:2002.

Preferably, the regenerated cellulose fibres are crimped staple fibres, which helps to reduce mechanical degradation of the fibres during processing of the filtration material to form the filter, and during subsequent assembly of the smoking article. The fibres can be crimped using a known method for crimping textile fibres, such as the method described in US 2,647,285.

The crimped staple fibres preferably have a stretched length of between about 10 mm and about 30 mm under a tension of between about 5 cN/denier and about 10 cN/denier. This provides an optimum balance between the mechanical integrity of the filter during use and the rate of dispersion of the filtration material after the filter has been discarded. The term "stretched length" is used herein to mean the average length of the crimped regenerated cellulose staple fibres when stretched under a given tensional load.

Preferably the crimped staple fibres have a denier of between about 0.5 and about 8.0, preferably between about 1.5 and about 5.5, most preferably between about 2.0 and about 3.2.

Preferably the staple fibres have a crimped rate of between about 3 curves and about 10 curves per 10 mm of fibre length, more preferably between about 6 curves and about 8 curves per 10 mm of fibre length.

The regenerated cellulose fibres may comprise Lyocell fibres. Lyocell fibres are defined as a regenerated cellulose fibre that is obtained by an organic solvent spinning process. Lyocell fibres suitable for use in filters according to the present invention are commercially available from Lenzing Aktiengesellschaft under the trademark Tencel®. Advantageously, the process of

manufacturing Lyocell fibres is more environmentally friendly when compared with the manufacture of traditional cellulose acetate, as well as other regenerated cellulose materials such as rayon, viscose, and such like.

5 In particular, the manufacture of cellulose acetate uses catalytic agents containing cobalt or manganese. The manufacture of cellulose acetate also produces a strong, unpleasant odour. In contrast, the cellulose or ground pulp used to form Lyocell is treated in a closed-loop process in which non-toxic solvents are recycled with a recovery rate of up to 99.5%. Furthermore, bleaching agents are not required in the production of Lyocell fibres. Any remaining emissions from the manufacture of Lyocell can be decomposed in biological
10 purification plants.

The filtration material may include other fibres in addition to the regenerated cellulose fibres. Such additional fibres can be incorporated into the filter by mixing the additional fibres with the regenerated cellulose fibres during manufacture of the filtration material. The additional fibres may be bound to the regenerated cellulose fibres using a suitable water-soluble binder,
15 such as those discussed above. For example, the filtration material of filters in accordance with the second aspect of the present invention may include cellulose acetate fibres to increase the mechanical strength of the filter. Alternatively, or in addition, the filtration material may include additional fibres which alter the appearance of the filtration material. For example, the appearance of the filtration material of filters in accordance with both aspects of the present
20 invention may be altered to more closely resemble the appearance of a traditional cellulose acetate tow filter. Exemplary fibres for altering the appearance of the filtration material include silk, cotton, polyester, linen, nylon and wool.

To further improve the rate of dispersion and degradation of the filter after it has been discarded, the wrapper may comprise a dissolvable plug wrap. The term "dissolvable" is used
25 herein to mean that the plug wrap is capable of dissolving into a solution with water. Advantageously, a dissolvable plug wrap will break open and disperse upon contact with water after the filter has been discarded, therefore exposing the underlying filtration material to the environment and increasing the rate of dispersion and degradation of the filtration material. In addition to being dissolvable, the plug wrap may be biodegradable.

30 In embodiments including a dissolvable plug wrap, the plug wrap comprises or consists of a sheet of polymeric film, wherein the polymeric film includes at least one water-soluble polymer. Using a polymeric film to form the plug wrap reduces cost and simplifies the manufacture of the plug wrap. Specifically, in contrast to a paper material, a polymeric film can be formed to inherently possess the required properties of a plug wrap, such as low gas
35 permeability, without the need for any further processing steps during manufacture.

-7 -

Furthermore, where it is desirable for the plug wrap to be transparent, it is easier to provide a transparent polymeric film than a transparent paper.

Preferably, a 5 mm by 5 mm square sample of the polymeric film will dissolve in less than 72 hours when placed in 25 ml of distilled water at a temperature of 22°C. The test is carried out in a container sized such that the depth of water is sufficient to completely submerge the square sample (although the buoyancy of the sample may be such that it floats on the surface of the water during the test). The sample is deemed to have dissolved when the water-soluble material is no longer visible to the naked eye.

Suitable polymeric materials for forming the polymeric film include, but are not limited to, polyvinyl alcohol, cellophane, starch, hydroxypropylmethyl cellulose (HPMC), carboxymethyl cellulose and combinations thereof.

Suitable polymeric films may be made entirely of one or more water-soluble polymers or may include additional polymers or inert inorganic fillers, which may or may not be dissolvable. The polymeric film may be single-layered or multi-layered. Where the film comprises multiple layers, the layers may be formed from the same polymeric materials or they may be formed from different polymeric materials. Where the layers are formed from different polymeric materials, each polymeric material comprises at least one water-soluble polymer.

According to the present invention, there is also provided a smoking article comprising an aerosol-forming substrate and a mouthpiece secured in axial alignment with the aerosol-forming substrate, the mouthpiece comprising a filter according to either aspect of the present invention.

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

Smoking articles according to the present invention may be filter cigarettes or other smoking articles in which the aerosol-forming substrate comprises tobacco material or another combustible material that is combusted to form smoke. Alternatively, smoking articles according to the present invention may be articles in which the aerosol-forming substrate comprises material that is heated to form an aerosol, rather than combusted. In one type of heated smoking article, tobacco material or another aerosol forming material is heated by one or more electrical heating elements to produce an aerosol. In another type of heated smoking article, an aerosol is produced by the transfer of heat from a combustible or chemical heat source to a physically separate aerosol forming material, which may be located within, around or

downstream of the heat source. The present invention further encompasses smoking articles in which a nicotine-containing aerosol is generated from a tobacco material, tobacco extract or other nicotine source, without combustion or heating.

5 **Test procedures**

ISO 14855-2005

10 The controlled composting biodegradation test is an optimised simulation of an intensive aerobic composting process where the biodegradability of a test under dry aerobic conditions is determined. The inoculum consists of stabilised and mature compost derived from the organic fraction of municipal solid waste. The test item is mixed with the inoculum and introduced into static reactor vessels where it is intensively composted under optimum oxygen, temperature and moisture conditions. The test is performed according to ISO 14855 (2005) method
15 “*Determination of the Ultimate Aerobic Biodegradability and Disintegration of Plastics under Controlled Composting Conditions*”, but in duplicate instead of in triplicate.

ISO 14851-2004

20 This test determines the aquatic, aerobic biodegradation under laboratory conditions. The test material is placed in a chemically defined liquid medium and spiked with micro-organisms. During the aerobic degradation, oxygen is consumed and carbonaceous material is converted to gaseous CO₂. NaOH pellets trap the CO₂ released and the induced-pressure drop is directly related to the consumed oxygen and the biodegradation of the test material.

25 The invention will now be further described, by way of example only, with reference to the accompanying drawings in which:

30 Figure 1 shows a smoking article in accordance with an embodiment of the present invention; and

Figure 2 shows the smoking article of Figure 1 with the filter unwrapped.

35 The filter cigarette 10 shown in Figures 1 and 2 comprises a wrapped rod 12 of tobacco cut filler which is attached at one end to an axially aligned filter 14 in accordance with the present invention. The filter 14 comprises a single segment of filtration material 16, the filtration

material 16 comprising randomly oriented regenerated cellulose fibres and cellulose acetate fibers, and triacetin. The filtration material 16 may also include other fibres to alter the appearance of the filtration material 16, such as silk fibres. The filtration material 16 may also comprise one or more binders and may include one or more additives to improve selective
5 phenol retention. The segment of filtration material 16 is circumscribed by a plug wrap 18, which may be dissolvable and may consist of a sheet of polymeric film comprising at least one water-soluble polymer. The wrapped tobacco rod 12 and the filter 14 are joined by a band 20 of tipping paper, which circumscribes the entire length of the filter 14 and an adjacent portion of the wrapped tobacco rod 12.

10 It will be appreciated that whilst the specific embodiment described above relates to conventional smoking articles comprising a filter and a tobacco rod, a similar arrangement of a filter in accordance with the present invention could also be used on a heated smoking article.

Claims

1. A filter for a smoking article, the filter comprising:
 - 5 a segment of filtration material, the filtration material comprising randomly oriented regenerated cellulose fibres and cellulose acetate fibers, the filtration material further comprising triacetin; and
 - a wrapper circumscribing the segment of filtration material.
- 10 2. The filter of claim 1, wherein the filtration material further comprises a low molecular weight polyether.
3. The filter of claim 1 or 2, wherein the filtration material comprises additional fibres selected from the group consisting of silk, cotton, polyester, linen, nylon, wool and combinations
15 thereof.
4. The filter of any preceding claim, wherein the triacetin is present in an amount of 1% to 15% by weight of the filtration material.
- 20 5. A filter for a smoking article, the filter comprising:
 - a segment of filtration material, the filtration material comprising randomly oriented regenerated cellulose fibres and a low molecular weight polyether; and
 - a wrapper circumscribing the segment of filtration material.
- 25 6. The filter of claim 2 or 5, wherein the low molecular weight polyether comprises polyethylene glycol.
7. The filter of claim 6, wherein the polyethylene glycol has a number average molecular weight of between 200 and 3600.
- 30 8. The filter of any preceding claim, wherein the regenerated cellulose fibres are crimped staple fibres.
9. The filter of claim 8, wherein the crimped staple fibres have a stretched length of
35 between 10 mm and 30 mm under a tension of between 5 cN/denier and 10 cN/denier.

-11 -

10. The filter of claim 8 or 9, wherein the crimped staple fibres have a denier of between 0.5 and 8.0 and a crimped rate of between 3 and 10 curves per 10 mm fibre length.

5 11. The filter of any preceding claim, wherein the regenerated cellulose fibres are Lyocell fibres.

12. The filter of any preceding claim, wherein the wrapper comprises a dissolvable plug wrap consisting of a sheet of polymeric material, wherein the polymeric material comprises at
10 least one water-soluble polymer.

13. A smoking article comprising:
an aerosol-forming substrate; and
a mouthpiece secured in axial alignment with the aerosol-forming substrate, the
15 mouthpiece comprising a filter according to any preceding claim.