

PATENT SPECIFICATION (11)

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- (21) Application No. 18457/72 - (22) Filed 20 April 1972 (19)
 (23) Complete Specification filed 25 June 1973
 (44) Complete Specification published 14 July 1976
 (51) INT. CL.³ B29D 7/00
 (52) Index at acceptance
 BSB 35Y 363 408
 A2C 1E3
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(54) IMPROVEMENTS IN OR RELATING TO FILTER MATERIAL

(71) We, BRITISH ROPES LIMITED, a British company of Warmsworth, Doncaster, Yorkshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with filter material and particularly, but not exclusively, with tobacco-smoke filter material.

It is well-known to produce filamentary material by splitting into a plurality of interconnected strands a polyolefin film which has been orientated in a longitudinal direction. The production of the material is known as fibrillation and the material i.e. a fibrillated polyolefin film will hereinafter be called "fibrillated material of the kind referred to".

It has now been found and provides the basis of the present invention that fibrillated material of the kind referred to is unexpectedly effective as a tobacco-smoke filter material provided that it has certain special structural characteristics. Compared with conventional filamentary tobacco-smoke filter materials, the special fibrillated material provides tobacco-smoke filters which give better filtration per unit pressure drop, and better filtration and a lower pressure drop are obtainable with a lower weight of material. Also, the material permits of unexpectedly easy production of tobacco-smoke filters, being readily handled by conventional machinery. The same properties which render the material very effective as a tobacco-smoke filter also render it very effective for various other filtration purposes.

According to the invention, a filter material comprises fibrillated material of the kind referred to having main generally longitudinally-extending strands interconnected by interconnecting strands and having a substantial number of free ends formed by severing main strands and/or strands which would otherwise have constituted interconnecting strands, the strands having a thickness in the range 5μ to 25μ and at least

40% (preferably at least 70%) of the strands having a width not greater than their thickness.

The word "thickness" as used herein in relation to strands means the dimension in the same direction as the thickness of the film from which the material is produced.

The preferred strand thickness is 14μ (i.e. 14 microns).

The number of severed ends hereinbefore mentioned present in the fibrillated material of the kind referred to may be optimised to improve significantly the filtration efficiency of the filter material whilst retaining sufficient strength for conventional continuous tow after-processing. The random disposal of these severed ends throughout the network effectively leads to a maximising of surface area which in turn gives improved filtration efficiencies.

The interconnecting strands preferably join the main strands at substantially regular spaced intervals. Thereby, if the material is expanded laterally, a network is produced which appears substantially regular, as distinct from a network in which the network has interconnections which are clearly randomly spaced and openings which randomly vary in size.

The polyolefin of which the polyolefin film is made may consist of polypropylene or polyethylene or a mixture of polypropylene and polyethylene or a copolymer of propylene and ethylene (see examples).

A whitening agent in the form of a solid material in finely divided form, preferably titanium dioxide, may be incorporated in the polyolefin prior to formation of the film. It has surprisingly been found that such agents facilitate the production of very narrow strands as hereinbefore referred to.

The present invention also provides a tobacco-smoke filter, and a cigarette having a tobacco-smoke filter, wherein the filter comprises a body of filter material as hereinbefore defined contained in a tubular outer sheet. Preferably, said main strands extend axially (i.e. longitudinally) along the filter.

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Preferably, in accordance with known practice, a binding agent is incorporated in the material, e.g. by spraying the agent on to the material.

The present invention also provides a method of making filter material as hereinbefore defined wherein said material is produced by passing said film over a roller having projecting pins thereon. The pin arrangement, the arc of contact between the film and the roller, and the relative speed of the film and the roller are such as to produce a fibrillated material having the characteristics defined above.

Advantageously, a plurality of superimposed films are passed simultaneously over the roller so that fibrillation of all of the films occurs.

The requirements can be determined by calculation and/or routine experiment by an experienced worker in the field of fibrillation. In order to obtain a substantial number of free ends as hereinbefore mentioned, it is desirable for the fibrillation ratio (i.e. the ratio of the surface speed of the roller to the film speed) to be within the range 1.05:1 to 3:1 and preferably 2:1 to 2.5:1.

In order to produce the preferred structure in which the interconnecting strands join the main strand at substantially regular intervals, pins are preferably arranged on the roller in parallel rows and in spaced staggered relationships, for example as specified in British Patent No. 1,073,741. Thereby, on rotation of the roller the paths of travel

of the pins in each row are different (i.e. laterally spaced from) the paths of travel of the pins in immediately adjacent rows.

To facilitate the production of the narrow strands, preferably each row of pins extends across the roller on a line which is inclined to a line parallel to the roller axis. Each row may be on a sinusoidal line which extends across the roller in a direction parallel to the roller axis. Alternatively, the pins may be arranged in pairs of parallel rows extending across the roller on lines inclined to lines parallel to the roller axis, immediately adjacent pairs of rows being oppositely inclined.

The following is an example of a method of producing tobacco-smoke filter material in accordance with the invention.

EXAMPLE 1

A copolymer of propylene and ethylene of Melt Index 0.8 containing approximately 20% by weight of copolymerised ethylene was extruded using a known blown film technique into a film of nominal 25 μ thickness. The film so produced was slit to required width (e.g. 11 inches) and the slit film was passed through a standard heating and stretching (orientating) system where it was longitudinally orientated with a stretch ratio of 7:1 to produce a film of 14 μ thickness. The orientated film was passed round part of the periphery of a pinned fibrillating roller. The physical data of the roller and the operating conditions were as follows:—

Fibrillator roller diameter	8 inches
Pins in spaced staggered relationship in parallel sinusoidal rows each extending across the roller in a direction parallel to the roller axis	
Number of rows of pins	90
Pin density in each row	40 pins per inch
Angle of rake of pins (angle of pins to tangent to roller in opposite direction to that of roller rotation)	60°
Pin projection	1 mm
Pin diameter	0.0145 inch
Arc of contact of film with roller	60°
Film input speed	150 ft/min
Surface speed of fibrillator roller	300 ft/min
	i.e. Fibrillation ratio of 2:1

The fibrillated film, which constituted filter material in accordance with the invention, was collected direct from the fibrillating stage by conventional means. Finally a number (e.g. three) of the fibrillated films were combined to give the required final linear yarn density (i.e. weight per unit length).

The fibrillated film so produced was then submitted to a crimping process for example involving passage of the film through a stuffer box crimper in a conventional known manner. Other conventional means of crimping, for example "gear tooth" crimping, false-twist crimping, etc., may also be used for inducing crimp in the fibrillated film.

The accompanying drawing in Figure 1 shows a piece of the fibrillated film in accordance with the invention expanded laterally to show the network formation before the crimping operation was carried out. In Figure 1, reference numeral 1 indicates main strands, 2 indicates interconnecting strands and 3 indicates free-ends. Figure 2 shows a cigarette 4 having a filter tip 5 made from filter material 6 in accordance with the invention in a tubular outer cover 7.

TEST 1

Tobacco smoke filters were made from fibrillated film in accordance with the invention made by the method hereinbefore described. The fibrillated film which had a linear yarn density of 8175 tex, was converted into filter rods using a conventional filter rod making machine. The filter rods were cut into filter tips of 15 mm length. Each filter tip contained 103 mg of fibrillated film. The pressure drop of the filter was 5.6 cm of water gauge at an airflow of 1050 ml per minute.

The filters were attached to cigarettes and were smoked using a smoking machine which took a puff of 35 ml volume and two seconds duration every minute. A comparison of the weights of Total Particulate

Matter (TPM) delivered from cigarettes having the filters with those from cigarettes without filters showed that the filter removed 40% of the TPM.

TEST 2

A 15 mm length of a commonly used cigarette filter made from cellulose acetate filaments (denier specification 3/46,000) contained 101 mg of cellulose acetate. When tested under the same conditions used in Example 1, the filter pressure drop was 5.5 cm of water gauge, and the filter removed 35% of the TPM.

TEST 3

Filters were made and tested as in Example 1, but in this case the relationship of film and roller speed was such that the fibrillated film did not contain severed ends. The filter contained 103 mg of fibrillated film and the pressure drop was 4.8 cm W.G. at a flow rate of 1050 ml per minute. The filtration efficiency for Total Particulate Matter was 35%.

The following is a further example of a method of producing tobacco-smoke filter material in accordance with the invention.

EXAMPLE 2

A copolymer of propylene and ethylene of melt index 0.8 (containing 20% copolymerised ethylene) was formed by a known blown film technique using an oscillating die into a film of 28 μ thickness. The double-layer of the film so produced was slit to required width (e.g. 6.4 inches). Three such widths of the double-layer of the film were superimposed and passed through a standard heating and stretching (orientating) system where they were longitudinally orientated with a stretch ratio of 7:1 to produce films of 14 μ thickness. The orientated films were passed round part of the periphery of a pinned fibrillating roller. The physical data of the roller and the operating conditions were as follows:—

Fibrillator roller diameter	...	...	...	...	...	8 inches
Pins in spaced staggered relationships in pairs of parallel rows extending across the roller on lines inclined to lines parallel to the roller axis, immediately adjacent pairs of rows being oppositely inclined						
Number of rows of pins	...	...	...	...	...	180
Pin density in each row	...	...	...	...	...	25 pins per inch
Angle of rake of pins (angle of pins to tangent to roller in opposite direction to that of roller rotation)	...	...	...	...	...	60°
Pin projection	...	...	...	...	...	1 mm
Pin diameter	...	...	...	...	...	0.0145 inch
Arc of contact of film with roller	...	...	...	...	...	45°
Film input speed	210 ft/min	...	...	...	...	
Surface speed of fibrillator roller	525 ft/min	...	...	...	...	Fibrillation ratio of 2.5:1.

The fibrillated product, being filter material in accordance with the invention, was collected direct from the fibrillating stage by conventional means.

The product was of 4444 tex (i.e. a linear yarn density (weight per unit length) of 40,000 denier).

The fibrillated material as obtained in the above example was then texturised as hereinbefore described (i.e. stuffer box crimped).

TEST 4

The texturising process was followed by a decrimping operation, producing a bloomed flocculent mass, the crimp characteristics of which were typically 16 crimps per inch.

On making up this material into a filter rod as described in Test 1, each filter rod (15 mm in length) was found to contain 72 mg of fibrillated film. The pressure drop of the filter was 4.2 of water gauge at an air-flow of 1050 ml per minute.

WHAT WE CLAIM IS:—

1. A filter material comprising fibrillated material of the kind referred to having main generally longitudinally-extending strands interconnected by interconnecting strands and having a substantial number of free ends formed by severing main strands and/or strands which would otherwise have constituted interconnecting strands, the strands having a thickness in the range 5μ to 25μ and at least 40% of the strands having a width not greater than their thickness (as herein defined).

2. A filter material according to claim 1 in which at least 70% of the strands have a width not greater than their thickness.

3. A filter material according to claim 1 or claim 2 in which the strand thickness is 14 microns.

4. A filter material according to any preceding claim in which the material contains the greatest number of severed ends compatible with sufficient strength for conventional tow after-processing.

5. A filter material according to any preceding claim in which the interconnecting strands join the main strands at substantially regularly spaced intervals.

6. A filter material according to any preceding claim in which the polyolefin of which the material is made consists of polypropylene or polyethylene or a mixture of polypropylene and polyethylene or a copolymer of propylene and ethylene.

7. A filter material according to any preceding claim in which a whitening agent in the form of a solid material in finely divided form is incorporated in the polyolefin of which the material is made before said film is formed.

8. A filter material according to claim 7 in which the whitening agent is titanium dioxide.

9. A filter material according to any preceding claim made from a plurality of superimposed polyolefin films which have been subjected to fibrillation while superimposed.

10. A method of making a filter material according to any preceding claim, comprising passing a polyolefin film having a thickness between 5μ and 25μ over a roller having projecting pins thereon, to form main generally longitudinally-extending strands interconnected by interconnecting strands and in which the pins are spaced to produce at least 40% of said strands having a width not greater than their thickness (as herein defined), and the pin spacing, roller speed and film speed are arranged to sever main strands and/or interconnecting strands to provide a substantial number of free ends.

11. A method according to claim 10 in which the fibrillation ratio (i.e. the ratio of the surface speed of the roller to the film speed) is within the range 1.05:1 to 3:1.

12. A method according to claim 11 in which the fibrillation ratio is within the range 2:1 to 2.5:1.

13. A method according to any of claims 10 to 12 in which the pins are arranged on the roller in parallel rows and in spaced staggered relationships.

14. A method according to claim 13 in which each row extends across the roller on a line which is inclined to a line parallel to the roller axis.

15. A method according to claim 13 in which each row is on a sinusoidal line which extends across the roller in a direction parallel to the roller axis.

16. A method according to claim 14 in which the pins are arranged in pairs of parallel rows extending across the roller on lines inclined to lines parallel to the roller axis, immediately adjacent pairs of rows being oppositely inclined.

17. A filter material made by a method according to any of claims 10 to 16.

18. A tobacco-smoke filter comprising a body of filter material according to any of claims 1 to 9 or claim 17.

19. A filter according to claim 18 in which said main strands extend axially (i.e. longitudinally) along the filter.

20. A method of making a filter material substantially as hereinbefore described in Example 1.

21. A method of making a filter material substantially as hereinbefore described in Example 2.

22. A filter material made by a method according to claim 20.

23. A filter material made by a method according to claim 21.



The fibrillated product, being filter material in accordance with the invention, was collected direct from the fibrillating stage by conventional means.

- 5 The product was of 4444 tex (i.e. a linear yarn density (weight per unit length) of 40,000 denier).

- 10 The fibrillated material as obtained in the above example was then texturised as hereinbefore described (i.e. stuffer box crimped).

TEST 4

- 15 The texturising process was followed by a decrimping operation, producing a bloomed flocculent mass, the crimp characteristics of which were typically 16 crimps per inch.

- 20 On making up this material into a filter rod as described in Test 1, each filter rod (15 mm in length) was found to contain 72 mg of fibrillated film. The pressure drop of the filter was 4.2 of water gauge at an air-flow of 1050 ml per minute.

- 25 WHAT WE CLAIM IS:—

- 30 1. A filter material comprising fibrillated material of the kind referred to having main generally longitudinally-extending strands interconnected by interconnecting strands and having a substantial number of free ends formed by severing main strands and/or strands which would otherwise have constituted interconnecting strands, the strands having a thickness in the range $5\ \mu$ to $25\ \mu$ and at least 40% of the strands having a width not greater than their thickness (as herein defined).

- 40 2. A filter material according to claim 1 in which at least 70% of the strands have a width not greater than their thickness.

3. A filter material according to claim 1 or claim 2 in which the strand thickness is 14 microns.

- 45 4. A filter material according to any preceding claim in which the material contains the greatest number of severed ends compatible with sufficient strength for conventional tow after-processing.

- 50 5. A filter material according to any preceding claim in which the interconnecting strands join the main strands at substantially regularly spaced intervals.

- 55 6. A filter material according to any preceding claim in which the polyolefin of which the material is made consists of polypropylene or polyethylene or a mixture of polypropylene and polyethylene or a copolymer of propylene and ethylene.

- 60 7. A filter material according to any preceding claim in which a whitening agent in the form of a solid material in finely divided form is incorporated in the polyolefin of which the material is made before said film is formed.

8. A filter material according to claim 7 in which the whitening agent is titanium dioxide. 65

9. A filter material according to any preceding claim made from a plurality of superimposed polyolefin films which have been subjected to fibrillation while superimposed. 70

10. A method of making a filter material according to any preceding claim, comprising passing a polyolefin film having a thickness between $5\ \mu$ and $25\ \mu$ over a roller having projecting pins thereon, to form main generally longitudinally-extending strands interconnected by interconnecting strands and in which the pins are spaced to produce at least 40% of said strands having a width not greater than their thickness (as herein defined), and the pin spacing, roller speed and film speed are arranged to sever main strands and/or interconnecting strands to provide a substantial number of free ends. 75

11. A method according to claim 10 in which the fibrillation ratio (i.e. the ratio of the surface speed of the roller to the film speed) is within the range 1.05:1 to 3:1. 80

12. A method according to claim 11 in which the fibrillation ratio is within the range 2:1 to 2.5:1. 85

13. A method according to any of claims 10 to 12 in which the pins are arranged on the roller in parallel rows and in spaced staggered relationships. 90

14. A method according to claim 13 in which each row extends across the roller on a line which is inclined to a line parallel to the roller axis. 95

15. A method according to claim 13 in which each row is on a sinusoidal line which extends across the roller in a direction parallel to the roller axis. 100

16. A method according to claim 14 in which the pins are arranged in pairs of parallel rows extending across the roller on lines inclined to lines parallel to the roller axis, immediately adjacent pairs of rows being oppositely inclined. 105

17. A filter material made by a method according to any of claims 10 to 16. 110

18. A tobacco-smoke filter comprising a body of filter material according to any of claims 1 to 9 or claim 17. 115

19. A filter according to claim 18 in which said main strands extend axially (i.e. longitudinally) along the filter.

20. A method of making a filter material substantially as hereinbefore described in Example 1. 120

21. A method of making a filter material substantially as hereinbefore described in Example 2.

22. A filter material made by a method according to claim 20. 125

23. A filter material made by a method according to claim 21.



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24. A tobacco-smoke filter comprising a body of filter material according to claim 22.

25. A tobacco-smoke filter comprising a body of filter material according to claim

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26. A cigarette having a tobacco-smoke filter according to claim 18, 19, 24 or 25.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1976.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.