CIGARETTE FILTER MATERIAL AND CIGARETTE FILTER

Inventors: Hiroki Taniguchi, Hyogo (JP); Takashi Hibi, Hyogo (JP)

Correspondence Address:
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747 (US)

Publication Classification

Int. Cl.
A24D 1/04 (2006.01)
A24D 3/02 (2006.01)
A24D 3/06 (2006.01)

U.S. Cl. .............................. 131/332; 131/361; 493/39

ABSTRACT

A cigarette filter material useful for selectively and efficiently reducing formaldehyde while maintaining a palatable component such as nicotine or tar is provided. A cigarette filter material is obtained by adhesively treating a substrate (such as a cellulose acetate fiber) with a dispersion comprising a particulate polysaccharide having an amino group (e.g., chitosan) and a medium. The medium may be a polar solvent (e.g., water, and an alcohol), and a plasticizer for the substrate. A cigarette filter comprising such cigarette filter material can efficiently and selectively reduce formaldehyde. For example, the cigarette filter ensures a retention of formaldehyde of not more than 65% while maintaining retentions of nicotine and tar of not less than 75%, respectively.
CIGARETTE FILTER MATERIAL AND CIGARETTE FILTER

TECHNICAL FIELD

[0001] The present invention relates to a cigarette filter material useful for selectively and efficiently removing an aldehyde (in particular formaldehyde) while maintaining a palatable component such as nicotine or tar, a process for producing the same, a cigarette filter formed from the cigarette filter material, and a cigarette comprising the cigarette filter.

BACKGROUND ART


[0003] However, most of the basic components as described above, in particular, synthetic polymeric amines, often have a smell of a specific amine odor due to decomposition of the amines or remain of low molecular weight components. Moreover, the basic component itself or a volatile substance contained therein vaporizes and shows toxicity to the human body in many cases. Incidentally, the volatilization of the basic component can be inhibited by acidifying a solution thereof in the impregnation step. The basic component, however, has a potential for liberation for some reason, e.g., contact with other basic substances or hydrolysis. Further, although a component such as an amino acid is often crystallized and has a low volatile, enough adsorption effects in smoke cannot be expected because the amino acid has a low adsorption activity in such a crystal state. Thus, it has been considered that an adsorbent containing a conventional basic component has some effects on removal of the acidic substance or the aldehyde, however such an adsorbent has been impractical for the adsorbent for cigarette filter in terms of safety or effects thereof.

[0004] On the other hand, among such basic substances, a chitosan derivative such as a chitin or a chitosan does not crystallize or volatilize. Moreover, it is known that the chitosan derivative is harmless to the human body and has an antibacterial activity. For example, Japanese Patent Application Laid-Open No. 100713/1999 (JP-11-100713A) (Document 8) discloses a chitosan-containing cellulose acetate fiber which contains a chitosan and has an antibacterial rate of not lower than 26%. This document mentions that dispersion and inclusion of a chitosan in a spin dope, for example, by a manner such as a method of adding or mixing a chitosan-dispersed liquid to a dope for cellulose acetate, wherein the dispersion contains a chitosan pulverized to a size smaller than a predetermined size (a maximum particle size of not larger than 3 μm), or a method of adding or mixing a chitosan to the solvent directly and preparing the size of the chitosan by a certain dispersion condition.

Moreover, cigarette filters made of such a chitin or chitosan derivative have also been proposed. For example, Japanese Patent Application Laid-Open No. 142600/1998 (JP-53-142600A) (Document 9) discloses a cigarette filter containing a chitin or chitosan derivative in a proportion of not less than 3 wt% relative to the cigarette filter. This document mentions that the chitin is poly-N-acetyl-D-glucosamine, and that a method for involving the chitin in the filter may include a method comprising directly blending a powder obtained from the chitin with a cigarette filter material, or a method comprising dissolving the chitin in a polar solvent, then extruding the solution in a coagulant such as isopropyl ether to give a fiber or film, and blending the fiber or film with a cigarette filter material. For example, Example 1 of the document mentions that after a cellulose acetate fiber bundle is enough opened with air, 6% by weight of triacetin is sprayed uniformly on the fiber bundle, and a chitin powder is attached with the fiber bundle in a proportion of 3 to 70% by weight relative to the bundle while the surface of the filament is sticky. Incidentally, the document describes that, in the case of particularly blending the chitin and chitin derivative with an acetate filter, the chitin and chitin derivative imparts a distinctive light aroma and palatability to a cigarette due to a synergistic effect between an acetyl group in the derivative and an acetyl group in the acetate. To be concrete, the document mentions that the reducing (or removing) rate of tar is 34 to 41% and that of nicotine is 28 to 29% in Examples so that the characteristics are equivalent or more on conventional article.

[0006] Japanese Patent Application Laid-Open No. 168373/1985 (JP-60-168373A) (Document 10) discloses a cigarette filter comprising, as a material, a fiber consisting of a chitin or a derivative thereof (e.g., a chitosan obtained by deacetylation of part or all of acetylamino groups in the chitin, and a compound which is obtained by etherifying, esterifying, hydroxyethylifying or O-methylifying OH groups or CH₃OH groups in a chitin). This document mentions that a production process for the fiber preferably includes a process comprising dissolving a chitin or a derivative thereof in a solvent to form a dope, and forming the dope into a fiber by a wet spinning process. The cigarette filter described in this document tends to adsorb tar or nicotine in use compared with a filter containing triacetylcellulose or a rayon as a material, and has an adsorption and adhesion performance one-and-a-half times to twice or more as high as a conventional filter.

Moreover, cigarette filters made of such a chitin or chitosan derivative have also been proposed. For example, Japanese Patent Application Laid-Open No. 111679/1987 (JP-62-111679A) (Document 11) discloses a cigarette filter material containing a polysaccharide ion exchange or a powder polysaccharide (e.g., a cellulose, an agarose, an amylose, a chitin, and a chitosan) for removing a mutagenic compound in smoke during smoking. This document mentions that the polysaccharide ion exchange or the powder polysaccharide can be used as a filter of a cigarette body, or in the form dispersed or inserted in a space of an acetate filter.

100% by weight. This document mentions that the chitin or chitosan may be used singly or in combination with a powder of fiber of silica, alumina, aluminosilicate, zirconia, a rayon, a cellulose, a protein or a synthetic resin. Moreover, this document mentions that the chitin or chitosan may be used by impregnating a substrate comprising a powder or a fiber of, for example, silica, alumina, aluminosilicate, zirconia, activated carbon, or a cellulose (such as rayon, cotton or wood pulp), a starch, a protein (such as a gelatin or a casein), or a synthetic resin (such as cellulose acetate, a polyethylene, a polyester or a nylon) with the chitin or chitosan solution, and then drying the resulting matter. According to the filter described in this document, a harmful component such as nicotine, tar or an aldehyde in smoke can be effectively adsorbed and collected. Incidentally, as a concrete method using the chitin or chitosan solution, Example 3 has mentioned that a filter was obtained by filling 80 mg of a powdery chitin or chitosan in a paper tube, covering each side of the paper tube with each 10 mg of a cotton nonwoven fabric to form a filter chip, and connecting a cigarette part of a commercially available HIGH LIGHT to the filter chip, where the filter had collecting rates of nicotine, tar, and an acrolein of 70%, 75%, and 96%, respectively.

Moreover, as described in the above-mentioned Document 12, even in the case of adding a chitosan particle to cellulose acetate filter which is used habitually as a cigarette filter, there is the possibility that the particle damages respiratory organs due to dropout.

Therefore, a cigarette filter enabling a small adsorption of tar or nicotine while maintaining selective adsorbability to formaldehyde has been required.


Patent Document 9: Japanese Patent Application Laid-Open No. 142600/1978 (JP-53-142600A) (Claims; page 2, the upper left column, line 1 to the upper right column, line 2; and Examples)

Patent Document 10: Japanese Patent Application Laid-Open No. 168373/1985 (JP-60-168373A) (Claims; and page 1, the right column line 16 to page 2, the upper right column line 15)


DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

It is therefore an object of the present invention to provide a cigarette filter material capable of reducing (or removing) efficiently an aldehyde (in particular, formaldehyde) while maintaining a taste and palatability (or aroma and palatability) component such as tar or nicotine at a high level.

Another object of the present invention is to provide an odorless cigarette filter material which has safety in oral intake and which is useful for selectively reducing an aldehyde (in particular, formaldehyde).

A further object of the present invention is to provide a process for conveniently and efficiently producing a cigarette filter material capable of selectively reducing an aldehyde (in particular, formaldehyde).
[0032] It is a still another object of the present invention to provide a cigarette filter capable of selectively reducing an aldehyde (in particular, formaldehyde) without deterioration of taste and palatability, and a cigarette comprising the cigarette filter.

Means to Solve the Problems

[0033] The inventors of the present invention made intensive studies to achieve the above objects. The inventors finally found that a cigarette filter material comprising a substrate (e.g., a substrate having a filter rod structure) treated with a dispersion that comprises a particulate polysaccharide having an amino group (e.g., a chitosan) and a medium (e.g., a hydroxyl group-containing solvent such as water or an alcohol, and a plasticizer such as triacetin), can selectively adsorb an aldehyde (in particular, formaldehyde) compared with palatable components such as tar and nicotine, probably because the filter exerts chemical adsorption performance due to the amino group in the polysaccharide. The present invention was accomplished based on the above findings.

[0034] That is, the cigarette filter material of the present invention comprises a substrate and a polysaccharide particle having an amino group, and the polysaccharide is adhered to the substrate, wherein the substrate is treated with a dispersion comprising the polysaccharide and a medium (or a dispersion medium for the polysaccharide). The polysaccharide is dispersed in the form of a particle in the dispersion. The substrate may have a filter rod structure (for example, may be a filter rod having a filter rod structure). In other words, the filter material may have a filter rod structure (specifically, the filter material may comprise a filament and have a filter rod structure). The polysaccharide having an amino group may be a chitosan. Incidentally, the filter rod structure means a structure (a filter structure) formed by arranging a given amount of mono-filaments (for example, about 3000 to 100000 mono-filaments) in the flow direction of a mainstream smoke. In the dispersion, the average particle size of the particulate polysaccharide may be about 0.1 to 100 μm (for example, about 0.5 to 50 μm). Moreover, in the dispersion, the medium may comprise at least one member selected from the group consisting of a polar solvent (particularly, a hydroxyl group-containing solvent), and a plasticizer for the substrate (e.g., tricetin, the plasticizer for the substrate is sometimes simply referred to as "plasticizer"). The hydroxyl group-containing solvent may be at least one member selected from the group consisting of water and an alcohol. The plasticizer may be an ester of a lower fatty acid (e.g., a C₃₋₄ alkane carboxylic acid such as acetic acid) with a polyol (e.g., glycerin, and a polyglycerin). The medium may contain a humectant capable of remaining in or adhering to the substrate even after the treatment. For example, the medium may contain a polyol as the humectant (for example, at least one member selected from the group consisting of a C₂₋₄ alkanediol, a di- to tetra-C₂₋₄ alkenylene glycol, and a C₃₋₅ alkanetriol (e.g., glycerin)).

[0035] The representative dispersion may contain, for example, a chitosan having a degree of deacetylation of not less than 70% and an average particle size of 1 to 20 μm, and a medium such as a C₅₋₆ alkanetriol (particularly, glycerin). Such a medium may contain water, an alkanol, the plasticizer, and others.

[0036] The cigarette filter material of the present invention comprises the substrate adhered the polysaccharide thereto (or contained the polysaccharide therein). In such a cigarette filter material, the adhering amount of the polysaccharide may be, for example, about 1 to 100 parts by weight relative to 100 parts by weight of the substrate.

[0037] Moreover, in the cigarette filter material of the present invention, the medium may reside (or remain) in the substrate. Such a remaining medium (or medium residing in the substrate) may constitute a part or all of the medium in the dispersion. The medium is allowed to contain or reside (or remain) in the substrate. Therefore, the selectively reducing (or removing) performance on an aldehyde (in particular formaldehyde) can be further improved. The content of such a medium may be, for example, about 0.5 to 100 parts by weight relative to 100 parts by weight of the substrate. Further, the adhering amount of the polysaccharide having an amino group may be about 1 to 80 parts by weight relative to 100 parts by weight of the substrate. The residual amount of the medium may be about 5 to 400 parts by weight relative to 100 parts by weight of the polysaccharide having an amino group. In particular, in the case of using the humectant as a medium, the medium can efficiently be allowed to remain or contain in (or adhere to) the substrate even after the adhesive treatment. For example, in the cigarette filter material, the remaining medium may at least comprise a polyol as a humectant, and the residual amount of the polyol may be about 3 to 200 parts by weight relative to 100 parts by weight of the polysaccharide having an amino group.

[0038] The cigarette filter material of the present invention may be produced by treating (or adhesively treating or allowing to adhere) a substrate with a dispersion comprising a particulate polysaccharide having an amino group and a medium that disperses the polysaccharide, as mentioned above.

[0039] Moreover, the present invention includes a cigarette filter made of the cigarette filter material. Since such a cigarette filter can efficiently and selectively reduce (or remove) an aldehyde (in particular formaldehyde), the present invention also includes a method for reducing an amount of an aldehyde (in particular formaldehyde) in mainstream smoke, which comprises forming the cigarette filter from the filter tow. In such a method, taste and palatability (or aroma and palatability) components (such as nicotine and tar) may be maintained at a high level. For example, the retention of formaldehyde may be not more than 65% while maintaining each retention of nicotine and tar of not less than 75%.

[0040] Further, the present invention includes a cigarette comprising said cigarette filter.

[0041] Incidentally, throughout this specification, the term "chitosan" means a deacetylated compound obtainable by heating chitin [β-1,4-poly-N-acetyl-D-glucosamine, (C₉H₁₇NO₃₃)ₙ] with a concentrated alkali solution, or other means, and the chitosan at least has a polymer structure, β-1,4-poly-D-glucosamine.

EFFECTS OF THE INVENTION

[0042] According to the present invention, the substrate (e.g., a substrate having a filter rod structure of a cellulose ester fiber) is adhesively treated with a dispersion comprising a particulate polysaccharide having an amino group and
a medium in combination. And the effect is that an aldehyde (in particular, formaldehyde) can be efficiently reduced (or removed) while maintaining a taste and palatability (or aroma and palatability) component such as tar or nicotine at a high level. Moreover, the cigarette filter material of the present invention is odorless and safe even in the case of oral intake because of using a polysaccharide (such as a chitosan). In addition, the cigarette filter material is useful for selective reduction (or removal) of an aldehyde (in particular, formaldehyde). The cigarette filter of the present invention can therefore selectively reduce (or remove) an aldehyde (in particular, formaldehyde) without deterioration of taste and palatability.

DETAILED DESCRIPTION OF THE INVENTION

0043] In the cigarette filter material of the present invention (hereinafter, may be simply referred to as “filter material” or “material”), a substrate contained in the filter material is treated (or adhesively treated) with a dispersion comprising a particulate polysaccharide having an amino group and a medium (or a dispersion medium for the polysaccharide), and at least the polysaccharide (and the medium) are attached to the substrate.

0044] That is, the polysaccharide having an amino group (e.g., a chitosan) plays an important role in removal of an aldehyde (in particular, formaldehyde) and usually forms a hydrogen bond. And, the ability of adsorbing to the aldehyde (in particular formaldehyde) is poor even in the case of being directly used as a cigarette filter material or a cigarette filter because of the lack of basic or nucleopetal property of the polysaccharide.

0045] Accordingly, in the present invention, a particulate polysaccharide having an amino group is added to a medium (or a dispersion medium for the polysaccharide), and a reducing (or removing) performance of the polysaccharide (or a selectively reducing (or removing) performance) on an aldehyde can be improved. Although it is not known exactly why such a selective reduction (or removal) performance on the aldehyde is improved, in the cigarette filter material of the present invention it is considered that the adhesive treatment of the substrate with the dispersion containing the polysaccharide and the medium contributes to, for example, (a) efficient adhesion of the polysaccharide to the substrate while maintaining the particulate form of the polysaccharide, (b) effective action of the amino group on the selective reduction of the aldehyde by inhibiting or weakening formation of a hydrogen bond due to the amino group of the polysaccharide under the action of the medium (and the medium residing in the substrate after the adhesive treatment), (c) extension of the surface area of the polysaccharide adhered to the substrate, (d) enhancement of the adherence of the polysaccharide adhered to the substrate, and (e) combination of these effects (a) to (d). Thus, such a material efficiently exerts the selectively reducing performance of the polysaccharide on the aldehyde.

0046] [Substrate]

0047] The substrate may be treated with a dispersion containing a polysaccharide having an amino group and a medium (or a dispersion medium), and may comprise, depending on the shape (or structure) of the substrate, for example, a fiber (or fibrous material) such as a natural or synthetic fiber (for example, a cellulose ester fiber (e.g., a cellulose acetate fiber), a cellulose fiber (for example, a wood fiber (e.g., a wood pulp fiber made from a softwood, hardwood, or others)), a species fiber (e.g., a cotton fiber such as a lint), a bast fiber, and a leaf fiber or a leaf stalk (e.g., Manil hemp, and New Zealand flax), a regenerated fiber (e.g., a viscose rayon, a cupra (cuppermannium rayon), and an artificial silk treated with nitric acid), a polyester fiber, a polystyrene fiber, a polyamide fiber, and a polyolefin fiber (e.g., a polyethylene fiber, and a polypropylene fiber), a particulate material (for example, an inorganic particle (such as an activated carbon, a diatomaceous earth, a silica gel, an alumina, a titanium oxide, a zirconia or a zeolite), a chip of wood, and a particle comprising other natural or synthetic polymer), and a protein (e.g., a gelatin, and a casein). These components of the substrate may be used singly or in combination.

0048] Among them, the preferred component of the substrate may include a fiber (a fibrous material), for example, a cellulose ester fiber. In the cellulose ester fiber, examples of the cellulose ester may include an organic acid ester such as cellulose acetate, cellulose propionate or cellulose butyrate, or a mixed fatty acid ester (e.g., cellulose acetate propionate, cellulose acetate butyrate, and cellulose acetate phthalate); an inorganic acid ester such as cellulose nitrate, cellulose sulfate or cellulose phosphate; a mixed acid ester such as cellulose nitrate acetate; and a cellulose ester derivative such as a polycaprolactone-grafted cellulose acetate. These cellulose esters may be used singly or in combination. Among them, the preferred cellulose ester may include an organic acid ester (for example, an ester of a cellulose with an organic acid having a carbon number of about 2 to 4), for example, cellulose acetate, cellulose propionate, cellulose butyrate, cellulose acetate propionate, cellulose acetate butyrate, and others. In particular, cellulose acetate (particularly cellulose diacetate) is preferred.

0049] The degree of polymerization of the cellulose ester may be usually about 10 to 1000 (for example, about 50 to 1000), preferably about 50 to 900 (for example, about 100 to 800), and more preferably about 200 to 800.

0050] Moreover, the degree of substitution of the cellulose ester (particularly cellulose acetate) may be, for example, selected from the range of about 1 to 3 (for example, about 1 to 2.9), preferably about 1.5 to 2.7, and more preferably about 1.7 to 2.6.

0051] As for the fiber (for example, the cellulose ester fiber) constituting the substrate, the average fiber length may be selected from the range of about 0.1 mm to 5 cm, for example, may be about 0.5 to 30 mm (for example, about 1 to 25 mm), preferably about 2 to 20 mm, and more preferably about 3 to 15 mm (for example, about 5 to 10 mm). Moreover, the average fiber diameter may be, for example, about 0.01 to 100 μm, preferably about 0.5 to 80 μm, and more preferably about 1 to 50 μm.

0052] Incidentally, the filament in the filter tow (for example, the cellulose ester filament) may have a crimping structure. And, the filament can have a non-crimping structure.

0053] Further, in the particle material (or the particulate material), the average particle size may be, for example, about 0.1 to 2000 μm, preferably about 10 to 1500 μm, and more preferably about 100 to 1000 μm.
The shape of the substrate (or the structure) may be suitably selected depending on the constitutive component form (e.g., the fiber, and the particle), and may be a shape of the constitutive component itself, such as a fibrous form or a particle form (or a particulate) or may be any form such as a capillicose form, a woven fabric form, a nonwoven fabric form, a filter rod structure (or a filter rod-like form, for example, a filter rod structure having a crimped structure), a paper form (or a paper or a paper structure), a sheet form and granules. Incidentally, the substrate having the paper structure may be obtained by making a staple from the fiber and forming the staple into a sheet through a dry or wet non-woven fabric process, or by mixing the staple with a beat pulp to give a slurry and forming the slurry into a paper.

Moreover, the substrate may be a pre-formed filter (for example, a filter rod formed from a cellulose ester (such as cellulose acetate) having a crimped structure). Such a pre-formed filter (or filter-like) substrate can be directly used as a cigarette filter after coating treatment (and drying).

The preferred substrate may be in the form of a filter rod formed from a fiber (or a filter (a filter substrate) having a rod formed from a fiber). A deal of particle matter such as nicotine and tar exist in smoke or aerosol, especially in mainstream smoke. In the case where the substrate comprises a fiber having a fibril, such a particle matter tends to collide with the fibril part. In the substrate having a fibril structure, therefore, the transmittance of nicotine or tar is decreased, and there is the possibility that the substrate is inappropriate for the object of the present invention. On the contrary, the later-mentioned filter rod (or filter having a filter rod structure) having a small amount of the fibril comprises a mono-filament in a broad sense (a multifilament having a substantially infinite continuous length) defined by the polymer engineering. Accordingly, such a filter rod (or filter) ensures to give an excellent delivery (or permeability) to nicotine or tar without collision with any particle matter.

From such a viewpoint, therefore, the substrate comprises the rod (or the filter rod) formed from a filament rather than the rod that has a sheet formed from a natural fiber having a fibril, e.g., a natural fiber such as a cotton lint or an absorbent cotton and a beat pulp (e.g., see Example 3 described in the above-mentioned Japanese Patent Application Laid-Open No. 31452/0995 (JP-7-31452A)).

Substrate Having Rod Structure or Filter Substrate Having Filter Rod Structure

As mentioned above, in the present invention, the most preferred substrate is a substrate having a filter rod (in particular, a filter substrate having a filter rod structure (or a filter rod substrate)). The filter rod (the filter having a rod structure) may comprise a mono-filament, that is a conventional filter material (fiber), and may be made by spinning (dry, melt or wet spinning). Examples of the fiber constituting the filter rod substrate (that is, a compact of a mono-filament) may include, for example, the cellulose fiber, the regenerated fiber (e.g., the viscose rayon fiber, and the cupra (cuprammonium rayon) fiber), the synthetic fiber such as the cellulose derivative fiber (e.g., the cellulose ester fiber), the polyester fiber, the polyurethane fiber, the polyamide fiber, the polyolefin fiber (e.g., the polyethylene fiber, and the polypropylene fiber), and the others. These fibers may be used singly or in combination.

Examples of the preferred fiber may include the cellulose fiber, the cellulose ester fiber, and the like. In particular, the fiber comprising at least the cellulose ester fiber is preferred. As the cellulose ester fiber, there may be mentioned a fiber similar to the above-mentioned one, for example, a fiber of an organic acid ester such as cellulose acetate fiber, cellulose propionate fiber or cellulose butyrate fiber (for example, a fiber of an organic acid ester having a carbon number of about 2 to 4); a mixed fatty acid ester fiber such as a cellulose acetate propionate fiber or a cellulose acetate butyrate fiber; and a cellulose ester derivative such as a polycaprolactone-grafted cellulose ester fiber. The preferred cellulose ester fiber may include, for example, a cellulose acetate fiber, a cellulose propionate fiber, a cellulose butyrate fiber, a cellulose acetate propionate fiber, a cellulose acetate butyrate fiber, and the like. In particular, the cellulose acetate fiber is preferred. These cellulose ester fibers may be also used singly or in combination.

In the filter rod (or the substrate having a filter rod structure), the degree of polymerization of the cellulose ester may be, for example, about 50 to 900, and preferably about 200 to 800. Moreover, the degree of substitution of the cellulose ester may be selected from the range of, for example, about 1.5 to 3.0.

The shape at cross section in the filament is not particularly limited to a specific one, and for example, may be any form such as a circular form, an elliptical form, an irregular form (for example, Y-shaped form, X-shaped form, I-shaped form, R-shaped form, and H-shaped form) or a shape at cross section of hollow fiber. The shape at cross section is preferably a polygonal irregular form such as Y-shaped form, X-shaped form, I-shaped form, R-shaped form or H-shaped form. The filament diameter and the filament length may be selected depending on the species of the fiber. For example, the filament diameter may be about 0.01 to 100 μm, and preferably 0.1 to 50 μm, and the filament length may be selected from the range of about 50 μm to 5 cm, and preferably about 100 μm to 3 cm in many cases. In particular, in the case where the substrate is the filter rod, the filament length preferably corresponds to the length of the filter rod or a part of the filter rod (e.g., about 3 to 30 mm, for example, about 10 mm, and about 25 mm).

The fineness of the fiber (e.g., the cellulose ester fiber) may be selected from the range of, for example, about 1 to 16 denier, and preferably 1 to 10 denier. The fiber such as the cellulose ester fiber may have either of a non-crimped structure or a crimped structure. The mono-filament that has a crimped structure is more preferred.

The filter rod substrate is in the form of a rod (a fiber bundle) formed by uniting (sheaving) filaments, for example, 3,000 to 1,000,000 mono-filaments (for example, 3,000 to 100,000 mono-filaments), preferably 5,000 to 100, 000 mono-filaments (particularly comprising cellulose ester filaments).

In the case of the filter rod substrate, the substrate may be formed by mixing and uniting a filament treated with an amino group-containing polysaccharide (for example, a chitosan) and an untreated (or raw) filament. The use of a cellulose ester (preferably cellulose acetate) as a material of such an untreated filament is advantageous to taste and palatability, and ensures to adjust the reducing rate of a formaldehyde and the residual rate of tar or nicotine.
The polysaccharide having an amino group (or amino group-containing polysaccharide) is not particularly limited to a specific one as far as the polysaccharide is a glucan derivative and has an amino group as a substituent. Representative examples of such a polysaccharide may include a chitosan.

The chitosan may be derived from a chitin whose the acetyl group is at least deacetylated, as mentioned above. The degree of deacetylation of the chitosan may be, for example, not lower than 20% (for example, about 30 to 100%), preferably not lower than 40% (for example, about 50 to 99%), and more preferably not lower than 60% (for example, about 65 to 98%).

Moreover, the base dissociation constant “pKb” of the chitosan at 25°C. may be, for example, not less than 5.5 (for example, about 6.3 to 10), and preferably not less than 6.5 (for example, about 6.8 to 9). In order to ensure higher reducing rate to the aldehyde (in particular, formaldehyde), the base dissociation constant may be usually not less than 7 (for example, about 7.3 to 11), preferably not less than 7.5 (for example, about 7.8 to 10), and more preferably not less than 8 (for example, 8.5 to 9.5).

Incidentally, the chitosan may be a chitosan derivative produced by derivatization. Such a chitosan derivative may include, for example, a chitosan salt (for example, a carboxylate such as a pyrrolidone carboxylate, a lactate or an alginate), a hydroxylated chitosan [for example, a chitosan protected (or substituted) by a hydroxyalkyl group (e.g., hydroxyethyl group, and hydroxypropyl group), such as hydroxypropylchitosan, and a glycercylated chitosan], and a cationized chitosan. Moreover, the chitosan derivative may include a chitosan in which the OH group or CH₂OH group constituting the chitosan skeleton is protected (or substituted) by a protecting group (or a substituent), for example, an alkyl group (e.g., a C₁₋₃ alkyl group such as methyl group), an ester group (or acyl group, for example, acetyl group).

The degree of polymerization of the polysaccharide having an amino group (in particular, the chitosan) may be selected from the range of about 10 to 5000 (for example, about 50 to 4000), and for example, may be about 20 to 3000, preferably about 300 to 2000 and more preferably about 50 to 1000 (for example, about 100 to 500).

The polysaccharide is dispersed in the form of a particulate (or a powder) in the dispersion. The polysaccharide may be in the form of a particulate (e.g., a particle form, a fine particle form, a pellet form), and may be a spherical form, an elliptical form, a columnar form (e.g., a prismatic form), an amorphous form, or other form.

The average particle size of the particulate polysaccharide may be selected from the range of about 0.05 to 500 µm (e.g., about 0.08 to 300 µm), and may be, for example, about 0.1 to 100 µm, preferably about 0.5 to 50 µm, and more preferably about 1 to 20 µm. Moreover, in the dispersion, the particulate polysaccharide may be, depending on the species of the medium or others, a primary particle or a secondary particle. By adjusting the particle size of the polysaccharide in the dispersion, the selectively reducing (or removing) performance on the aldehyde (in particular, formaldehyde) can be enhanced.

In the dispersion, the content (dispersing amount) of the polysaccharide may be selected from the range of about 0.01 to 200 parts by weight relative to 100 parts by weight of the medium (the whole medium) depending on the species of the medium, and may be, for example, about 0.05 to 150 parts by weight (e.g., about 0.1 to 100 parts by weight), preferably about 0.2 to 100 parts by weight (e.g., about 0.5 to 90 parts by weight), and more preferably about 1 to 80 parts by weight (e.g., about 1 to 70 parts by weight).

The medium (or the dispersion medium) is not particularly limited to a specific one as far as the medium is a solvent (or a poor solvent to the polysaccharide) capable of dispersing the particulate polysaccharide. Such a medium may be selected depending on the species of the polysaccharide (e.g., the polymerization degree, and the degree of deacetylation), and may be a conventional solvent (a polar solvent, a nonpolar solvent) or may be a medium (a solvent) capable of dissolving (or plasticizing) the substrate. Moreover, the medium also includes a solid humectant as described later. The media may be used singly or in combination.

The solvent may be a nonpolar solvent [for example, a solvent having a relatively low dielectric or non-dielectric constant (e.g., a solvent having a dielectric constant of less than 15), e.g., a hydrocarbon (e.g., an aliphatic or aliphatic hydrocarbon, an aromatic hydrocarbon, and a halogenated hydrocarbon), and a chain carboxylic acid ester (for example, an acetic acid ester such as ethyl acetate or butyl acetate)], and usually may comprise at least a polar solvent (or a polar liquid). Incidentally, the polar solvent does not usually melt (or fuse) the substrate.

The polar solvent may include, for example, water, an alcohol, a ketone (e.g., a dialkyl ketone such as acetone, methyl ethyl ketone or methyl isobutyl ketone), and an ether (for example, a cyclic ether (e.g., tetrahydrofuran), a dialkyl glycol alkyl ether (e.g., diethylene glycol dimethyl
ether), and a glycol ether ester (e.g., ethylene glycol monomethyl ether acetate, and propylene glycol monomethyl ether acetate).

[0082] The preferred polar solvent may include, from the viewpoint of efficient releasing a hydrogen bond due to the amino group of the polysaccharide, a hydroxyl group-containing solvent such as water or the alcohol. Examples of the alcohol may include a monool [for example, an alkanol such as a C₁₋₁₀ alkanol (e.g., methanol, ethanol, 1-propanol, isopropanol, n-butanol, 2-butanol or isobutanol, preferably a C₄₋₆ alkanol, more preferably a C₁₋₆ alkanol, and particularly a C₁₋₃ alkanol), a cycloalkanol (e.g., a C₅₋₁₀ cycloalkanol such as cyclohexanol), an alkylene glycol monoalkyl ether (e.g., a methyl cellosolve, an ethyl cellosolve, a butyl cellosolve, and a propylene glycol monomethyl ether), a dialkylene glycol monoalkyl ether (e.g., methylycarbitol, and ethylcarbitol), and a (poly)alkylene-glycol monoacrylate (e.g., ethylene glycol mono acetate), and a polyol [α diol [for example, an alkanediol (e.g., a C₅₋₁₀ alkanediol such as ethylene glycol, propylene glycol, trimethylene glycol, 1,3-butanediol, 1,4-butanediol, 1,5-pentanediol or hexylene glycol, preferably a C₂₋₆ alkanediol, more preferably a C₂₋₄ alkanediol, and particularly a C₂₋₃ alkanediol], a polyalkylene glycol (e.g., a di-to tetra C₃₋₆ alkylene glycol such as diethyleneglycol, dipropyleneglycol, triethyleneglycol or tripropylene glycol), a triol [for example, an alkanetriol (a C₄₋₁₀ alkanetriol such as glycerin or 1,2,6-hexanetriol, preferably a C₅₋₁₀ alkanetriol, and more preferably a C₃₋₆ alkanetriol), a tetra- or more hydric polyol [for example, a multimer of a tri- or more polyol (e.g., the alkanetriol) (for example, a polyglycerin such as diglycerin or triglycerin)].

[0083] The polar solvents may be used singly or in combination.

[0084] In particular, the polar solvent may comprise at least a polar solvent as a humectant (a polar solvent acting as a humectant, hereinafter, may be referred to as a wetting polar solvent). Such a polar solvent may include, among the above-mentioned polar solvents, the dialkylene glycol monoalkyl ether, the polyalkylene glycol monoacrylate, and the polyol [for example, the alkanediol, the alkanetriol (e.g., glycerin)]. The most preferred wetting polar solvent includes the polyol, in light of having a plurality of hydroxyl groups and being excellent in a capacity for releasing the hydrogen bond due to the amino group of the polysaccharide.

[0085] That is, the polyol resides (or remains) in or adheres to the cigarette filter material (substrate) even after the adhesive treatment (and drying) because of a relatively high boiling point thereof, and therefore acts as a humectant (or a moisture component). More specifically, the wetting polar solvent (e.g., the polyol) is not volatile in the substrate after the adhesive treatment, and remains in the cigarette filter material (or the substrate). In addition, the polar solvent is excellent in release of the hydrogen bond due to the amino group of the polysaccharide, and is useful for improving the performance for selective reduction of the aldehyde. Furthermore, such a humectant remaining in the cigarette filter material or the substrate ensures to stably maintain the performance for selective reduction of the aldehyde for a long period. Moreover, the wetting polar solvent seems to have a function to inhibiting volatilization of water or the monool (e.g., the alkanol) after the adhesive treatment. Thus, the hydrogen bond due to the amino group of the polysaccharide can be effectively released (or loosened) by allowing such a polar solvent to remain in the substrate.

[0086] The wetting polar solvent may be used singly or in combination. Moreover, a volatile medium [in particular, a volatile polar solvent or non-wetting polar solvent, for example, at least one solvent selected from the group consisting of water and a monool (for example, an alkanol such as a C₁₋₆ alkanol)] and a wetting polar solvent may be used in combination.

[0087] The boiling point of the wetting polar solvent (particularly, a polyol) may be, for example, not lower than 150°C (e.g., about 180 to 500°C), preferably not lower than 200°C (e.g., about 210 to 400°C), more preferably not lower than 220°C (e.g., about 230 to 350°C), and particularly not lower than 250°C (e.g., about 260 to 320°C).

[0088] Incidentally, the boiling point of the volatile medium (e.g., a volatile polar solvent such as water or the alkanol) may be, for example, lower than 150°C (e.g., about 35 to 145°C), preferably about 40 to 130°C, and more preferably about 50 to 120°C.

[0089] The medium capable of plasticizing the substrate may include a general plasticizer for the substrate. Such a medium capable of plasticizing the substrate can efficiently enhance an adherence between the substance and the substrate by plasticizing the substrate. Examples of the plasticizer may include a phosphoric acid ester (for example, an aliphatic phosphoric acid ester (e.g., a triC₁₋₁₂ alkyl ester of a phosphoric acid such as triethyl phosphate), an aromatic phosphoric acid ester (e.g., a C₁₋₁₀ alkyldiC₁₋₅ arylic ester of a phosphoric acid such as octyl diphenyl phosphate, and a tricyC₁₋₅ arylic ester of a phosphoric acid such as triaryl phosphate), and a condensated phosphoric acid ester [e.g., a dithyoxycarbene bis(diaryl phosphate) such as resorcinol bis(diphenyl phosphate)], a carboxylic acid ester [for example, an aromatic carboxylic acid ester (e.g., an aromatic polycarboxylic acid ester such as an aromatic polycarboxylic acid ester (for example, a phthalic acid ester, e.g., a diC₁₋₁₂ alkyl ester of phthalic acid such as dimethyl phthalate, diethyl phthalate, dibutyl phthalate, dihexyl phthalate or dioctyl phthalate, and a C₁₋₆ alkoxy C₁₋₁₂ alkyl ester of phthalic acid such as dimethoxethyl phthalate), an aliphatic carboxylic acid ester (for example, an aliphatic dicarboxylic acid ester (e.g., a C₁₋₁₂ alkyl ester of a C₆₋₁₂ dicarboxylic acid such as an adipic acid ester (such as dibutyl adipate), dioctyl adipate or dibutoxyethylene adipate), an azelanic acid ester corresponding to such an adipic acid ester), a citric acid ester (e.g., acetyltetrubutyl citrate), an unsaturated fatty acid ester (e.g., a C₁₋₁₀ alkyl ester of a C₆₋₁₀ alkenecarboxylic acid such as butyl oleate or methylyl acetate), a fatty acid ester of a poly or hydroxyl alcohol (e.g., the above-mentioned polyol, for example, a tri- or hexahydric alkanol such as glycerin, trimethylol propane, penterythritol or sorbitol), and an ester oligomer (e.g., a caprolactone oligomer).

[0090] The fatty acid ester of the polyol may include an ester of a lower fatty acid (e.g., a C₁₋₆ alkanecarboxylic acid such as acetic acid) with a polyol (for example, an alkanolmono- to triacylate (e.g., a C₃₋₆ alkanolmono- to
tric-acylate such as monoacitin, diacetin, or triacetin, preferably a glycerin mono- to tric-acylate], a lower fatty acid ester of a polyl or oligomer [for example, a lower fatty acid ester of a polyol dimer or trimer such as a mono- to tetracytlate of an alkane triol dimmer (e.g., a diC₃₋₆alkane triol mono- to tetraC₃₋₆acylate such as diglycerin tetractetate), and others.

[0091] Among these plasticizers, as a plasticizer used in combination with a substrate comprising a cellulose ester (particularly, a cellulose acetate), a lower fatty acid ester of a polyl, for example, an acitin (e.g., a glycerin di- to triacetate such as diacetin or triacetin), is preferably used from the viewpoint of excellent swelling capacity to the substrate. In particular, among the lower fatty acid esters of the polyols, a polyl di- or tric-acylate (particularly, a C₃₋₆alkane triol di- or tric-acylate such as diacetin) is excellent in a function improving adsorption performance to an aldehyde of the polysaccharide containing an amino group, and may be most preferably used. Therefore, as the plasticizer used in combination with the substrate comprising a cellulose ester, a plasticizer comprising at least polyl di- or triacetate (particularly, diacetin, triacetin, and the like), particularly, an acitin, may be preferably used.

[0092] In particular, the plasticizer may comprise at least a polyl diacetate (particularly, a C₃₋₆alkane triol diC₃₋₆acylate such as diacetin). For example, the plasticizer may comprise diacetin and triacetin.

[0093] Triacetin sometimes contains diacetin and/or monoacetin. In usual, industrial triacetin contains diacetin and/or monoacetin as impurities. In a plasticizer at least containing a polyl diC₃₋₆acylate (particularly, diacetin), the content of the polyl diC₃₋₆acylate (particularly, diacetin) may be not less than 1% by weight (e.g., about 2 to 100% by weight), preferably about 3 to 80% by weight, and more preferably about 5 to 60% by weight (e.g., about 8 to 40% by weight) relative to the total amount of the plasticizer (particularly, an acitin). The combination of diacetin and other acitin (particularly, triacetin) ensures to moderately enhance the viscosity of the dispersion with improving the performance for adsorbing an aldehyde. Such a lower fatty acid ester of a polyl (particularly, diacetin, triacetin, and a mixture thereof) is excellent in capability of plasticizing a cellulose ester, as well as has capability of releasing the hydrogen bond due to the amino group of the polysaccharide. Therefore, such a lower fatty acid ester of a polyl can enhance selective reduction of an aldehyde (particularly, formaldehyde), and further, can be preferably used because of high safety.

[0094] The plasticizers may be used singly or in combination.

[0095] Incidentally, the medium capable of plasticizing the substrate may be usually in the form of a liquid (liquid form at a room temperature). Moreover, the medium capable of plasticizing the substrate usually has a relatively high boiling point [for example, a boiling point of about 150 to 500°C, preferably about 200 to 450°C, and more preferably about 220 to 400°C (e.g., about 250 to 380°C)], and the medium after the adhesive treatment often remains (or resides) in the substrate or the cigarette filter material without volatilization or drying. Therefore, the medium capable of plasticizing the substrate may be nonvolatile.

[0096] The preferred medium may include, depending on the species of the substrate, a ester of a lower fatty acid with a polyl (for example, a glycerin triC₃₋₆acylate such as triacetin) in the light of oral safety for human health. These media capable of plasticizing the substrate may be used singly or in combination.

[0097] Incidentally, throughout this specification, the medium also includes a solid medium (solid at a room temperature) as long as the solid medium can dissolve in the liquid medium (e.g., the polar solvent, and the plasticizer). That is, the medium may comprise a solid medium and a medium capable of dissolving the solid medium. Such a solid medium may act as a humectant similar to the wetting polar solvent, by remaining in the substrate even after adhesive treatment (and drying).

[0098] The solid medium may include, for example, a synthetic polymer having a hydroxyl group or an ether bond (an ether group) [for example, a polyvinyl alcohol, and a polyalkylene glycol (e.g., a polyethylene oxide, a polypropylene oxide, and a polyethylene oxide-polypropylene oxide)], a natural polymer (e.g., a gelatin, a dextrin, and a starch), a cellulose derivative [for example, a cellulose derivative having a hydroxyl group (e.g., a hydroxyethyl cellulose, and an alkyl-hydroxyalkyl cellulose such as ethylhydroxyethyl cellulose), and a cellulose ether (e.g., a carboxyalkyl cellulose such as carboxymethyl cellulose, and an alkyl cellulose such as ethyl cellulose)], a carbohydrate (or a saccharide) [for example, a monosaccharide (e.g., xylose, and glucose), a disaccharide (e.g., cellobiose, and trehalose), and a sugar alcohol (e.g., an inositol compound such as inositol or bornitol, and xylitol)]. These solid media may be used singly or in combination.

[0099] Typical Examples of the medium may include (1) a medium (or a dispersion medium) comprising water and/or a monool (e.g., an alkanol including the polyl) (which may comprise the above-mentioned solid humectant or others), (2) a medium (or a dispersion medium) comprising the plasticizer (e.g., a lower fatty acid ester of a polyl) (which may comprise the above-mentioned solid humectant or others), and others.

[0100] The preferred medium may include a medium containing the wetting polar solvent, for example, (1a) a medium comprising water and/or a monool and the wetting polar solvent (for example, a polyl such as glycerin), (2a) a medium comprising the plasticizer and the wetting polar solvent, and the like.

[0101] Incidentally, in the case of the medium containing the wetting polar solvent, the proportion of the wetting polar solvent may be selected from the range of 0.01 to 100% by weight (e.g., 0.05 to 50% by weight) relative to the medium in the dispersion. For example, the proportion may be about 0.1 to 30% by weight, preferably about 0.3 to 20% by weight, and more preferably about 0.5 to 15% by weight (e.g., about 1 to 10% by weight).

[0102] In particular, in the dispersion of the above embodiment (1a), the proportion of the wetting polar solvent may be, for example, about 0.05 to 30 parts by weight (e.g., about 0.1 to 20 parts by weight), preferably about 0.3 to 15 parts by weight, and more preferably about 0.5 to 10 parts by weight (e.g., about 1 to 8 parts by weight) relative to 100 parts by weight of water and/or the monool.

[0103] Incidentally, depending on the species of the medium to be used and the combination thereof, various
performances or properties are sometimes imparted to the resulting cigarette filter material. For example, the medium containing a kind of the polar solvent such as an alkanol (e.g., a C<sub>1</sub>-alkanol) seems to efficiently increase the surface area of the polysaccharide adhered to the substrate probably because the medium can efficiently prevent or inhibit swelling or aggregation of the polysaccharide. In the case where the medium containing a kind of the polar solvent such as water or a polyol is used, agglutination of the polysaccharide is caused in the medium. Then the surface area of the polysaccharide adhered to the substrate is reduced, while such a medium efficiently tends to inhibit or reduce an influence on a hydrogen bond in a hydroxyl group in the polysaccharide. At last, the ability of selective reduction on formaldehyde is increasing.

[0104] [Cigarette Filter Material]

[0105] In the cigarette filter material of the present invention, the polysaccharide having an amino group is adhered to the substrate. The shape of the polysaccharide adhered to the substrate usually corresponds to that of the polysaccharide in the dispersion, and is often a particulate form. Moreover, the particulate polysaccharide adhered to the substrate may be aggregated.

[0106] In the cigarette filter material of the present invention, the adhering amount (or the content or impregnating amount) of the polysaccharide may be selected from the range of not more than 100 parts by weight (for example, about 1 to 100 parts by weight) relative to 100 parts by weight of the substrate depending on the species of the medium. For example, the adhering amount may be about 1 to 80 parts by weight, preferably not more than 60 parts by weight (e.g., about 2 to 60 parts by weight), preferably not more than 40 parts by weight (e.g., about 4 to 30 parts by weight), particularly not more than 30 parts by weight (e.g., about 4 to 30 parts by weight), and usually not more than 20 parts by weight (e.g., about 5 to 20 parts by weight). In the case where the content of the polysaccharide is too large, there is a possibility that the adsorption amount of tar or nicotine is increased.

[0107] Moreover, in the cigarette filter material, the surface area (the specific surface area) of the polysaccharide adhered to the substrate may be, for example, not larger than 50 m<sup>2</sup> (e.g., about 0.01 to 40 m<sup>2</sup>), preferably about 0.1 to 30 m<sup>2</sup> and more preferably about 0.5 to 20 m<sup>2</sup> per gram of the polysaccharide, in response to the species of the medium or the particle size of the polysaccharide.

[0108] In particular, in the case of using the alkanol, the plasticizer or others as a medium, the surface area (the specific surface area) of the polysaccharide adhered to the substrate is relatively large, and may be, for example, about 1 to 50 m<sup>2</sup>, preferably about 3 to 30 m<sup>2</sup> and more preferably about 5 to 20 m<sup>2</sup> (e.g., about 6 to 15 m<sup>2</sup>) per gram of the polysaccharide.

[0109] Incidentally, as described above, the surface area of the polysaccharide varies depending on the species of the medium. If unifying the condition such as the species of the medium or the particle size of the polysaccharide, the larger the surface area of the polysaccharide indicates the higher the performance for selective reduction of the aldehyde (particularly formaldehyde). On the other hand, if using the medium containing a component such as water or the polyol, the surface area (the specific surface area) of the polysaccharide has a tendency to become small, as described above. However, such the medium (particularly containing the polyol) is excellent in a performance for releasing the hydrogen bond due to the amino group. Therefore, using said medium and residing of the medium on the substrate ensures to enhance the performance for selectively reducing (or removing) the aldehyde of the polysaccharide even when the specific surface area of the polysaccharide is small.

[0110] Moreover, in the cigarette filter material, the medium may be completely removed from the material by drying (including volatilization or air drying), or may partly or wholly reside in the substrate. In particular, the wetting polar solvent (such as the polyol), the plasticizer, and the medium (such as the solid medium) reside in the cigarette filter material or substrate even after drying in many cases. Incidentally, the volatile medium (e.g., water, and the alkanol) may be allowed to reside in the substrate or cigarette filter material by adjusting the drying condition, or others. For example, in a fiber (such as a fiber comprised of cellulose acetate filaments) having a relatively large surface area, the fiber can hold absorbed water by going through a usual production process. However, such an absorbed water content is few milligrams (for example, about 1 to 3 mg) per 100 mg of the substrate at most. In particular, in the case of carrying out vacuum drying or others, the fiber becomes an absolute dry state (the absorbed water content is almost zero).

[0111] In the cigarette filter material, the residual amount (the adhering amount, the content) of the medium may be selected from the range of 0 to 100 parts by weight relative to 100 parts by weight of the substrate, depending on the amount or concentration of the dispersion, and for example, may be about 0.5 to 100 parts by weight (e.g., about 0.8 to 90 parts by weight), preferably about 1 to 80 parts by weight (e.g., about 1.5 to 80 parts by weight), more preferably about 2 to 70 parts by weight (e.g., about 3 to 60 parts by weight), particularly about 4 to 50 parts by weight (e.g., about 5 to 30 parts by weight), and usually about 5 to 20 parts by weight (e.g., about 5 to 15 parts by weight).

[0112] In particular, in the case of using the medium containing the wetting polar solvent, the remaining medium comprises the wetting polar solvent (particularly, a polyol as a humectant), and the residual amount (the adhering amount, the content) of the wetting polar solvent (particularly, the polyol) may be selected from the range of 0.1 to 100 parts by weight relative to 100 parts by weight of the substrate, and may be, for example, about 1 to 100 parts by weight, preferably about 2 to 60 parts by weight, more preferably about 3 to 40 parts by weight, and particularly about 5 to 20 parts by weight (e.g., about 5 to 15 parts by weight). Incidentally, the residing proportion (the adhesion proportion, the content proportion) of at least one member (selected from the group consisting of water, the monoal (e.g., a C<sub>1</sub>-alkanol) and the plasticizer) relative to the wetting polar solvent [the former/the latter (weight ratio)] may be about 99/1 to 0/100, preferably about 95/5 to 5/95, and more preferably about 90/10 to 10/90 (e.g., about 85/15 to 15/85).

[0113] Moreover, the residual amount (the adhering amount, the content) of the medium may be about 0 to 500 parts by weight, preferably about 5 to 400 parts by weight, and more preferably about 10 to 300 parts by weight (e.g.,
about 20 to 200 parts by weight) relative to 100 parts by weight of the polysaccharide. Further, in the case of using the medium containing the wetting polar solvent, the residing medium comprises the wetting polar solvent (particularly, the polyol as a humectant), and the residual amount (the adhering amount, the content) of the wetting polar solvent (particularly, the polyol as a humectant) may be, for example, about 1 to 300 parts by weight, preferably about 3 to 200 parts by weight, more preferably about 5 to 180 parts by weight (e.g., about 8 to 150 parts by weight), and particularly about 10 to 120 parts by weight relative to 100 parts by weight of the polysaccharide.

[0114] In particular, in the case where the medium containing the hydroxyl group-containing polar solvent (e.g., water, and an alcohol (a monool, the polyol)) is used, the residual amount (the adhering amount, the content) of the medium may be, in terms of hydroxyl group of the medium (or in the total amount of the hydroxyl group in the whole medium), not less than 0.1 mol (e.g., about 0.3 to 500 mol), for example, not less than 0.5 mol (e.g., about 0.8 to 300 mol), preferably not less than 1 mol (e.g., about 1.2 to 150 mol), more preferably not less than 1.5 mol (e.g., about 1.6 to 100 mol), and particularly about 1.8 to 80 mol (e.g., about 2 to 50 mol) relative to 1 mol of the glucose (or monosaccharide) unit of the polysaccharide.

[0115] Incidentally, in the cigarette filter material of the present invention, the amount of the polysaccharide or the medium may be adjusted depending on the length of the medium. For example, in the case of a short filter, since the delivery of nicotine and tar becomes higher, the amount of the polysaccharide can be increased. Moreover, based on this, the amount of the medium may be increased.

[0116] Incidentally, the cigarette filter material may further contain other component(s), for example, an inorganic fine powder (e.g., kaolin, talc, diatomaceous earth, quartz, calcium carbonate, barium sulfate, titanium oxide, and alumina), a heat stabilizer (e.g., a salt of an alkali or alkaline earth metal), a coloring agent, a whitening agent, an oil, a retention aid for paper, a sizing agent, an adsorbent (e.g., an activated carbon), a biodegradation or photodecomposition accelerator (e.g., an anatase-type titanium oxide), and a natural polymer or a derivative thereof (e.g., a cellulose powder). These other components may be used singly or in combination.

[0117] The form of the cigarette filter material of the present invention is not particularly limited to a specific one, and may be, for example, any of a fibrous form, a capillary form, a woven fabric form, a non-woven fabric form, a tow-like form, a sheet form and a particle form (or a particulate), depending on the form of the substrate. Moreover, the form of the cigarette filter material may be a filter rod form. Incidentally, the substrate (that is, a substrate before an adhesive treatment) may have such a form in advance, or such a form may be given by molding or shaping an adhesive-treating substrate (for example, a fibrous substrate, and a particulate substrate) by a conventional method (for example, a paper-making method). In particular, the cigarette filter material is preferably a filter-rod form (particularly a filter bundle having a rod structure), as mentioned above.

[0118] [Production Process of Cigarette Filter Material]

[0119] The cigarette filter material of the present invention may be obtained by adhesively treating a substrate with the dispersion (a dispersion comprising a particulate polysaccharide having an amino group and a medium (or a dispersion medium for the polysaccharide)). That is, the cigarette filter material of the present invention may be usually obtained by adhesively treating a substrate with the dispersion to the substrate (or contain) at least the polysaccharide having an amino group (and if necessary the medium (e.g., the wetting polar solvent)).

[0120] The adhesive treatment method (treating method) may be appropriately selected depending on the shape of the substrate (e.g., a fibrous form, and a filter rod form), the material thereof, and is not particularly limited to a specific one as far as the substrate and the dispersion can be contacted with each other. For example, such a method may include (i) a method of dipping (or impregnating or immersing) the substrate in the dispersion, (ii) a method of spraying or sparging (or spreading) the substrate with the dispersion, (iii) a method of coating the substrate with the solution of the dispersion, and others. These treatment methods may be used singly or in combination.

[0121] Such a treatment method of the present invention may be introduced into the existing manufacturing apparatus for cigarette filter, in particular an apparatus for producing a cigarette filter having a filter rod made from a cellulose acetate filament. For example, the polysaccharide (and the dispersion) may be adhered to the substrate by bringing the dispersion into contact with the substrate through the above method (e.g., coating, and dipping) during the spinning step of a filter tow. Further, the adhesive treatment may be carried out through a manner (such as spraying, coating, or dipping) in a step for forming a filter rod (a rolling up step) by winding off a tow band from a bale of filter tow band to adhere the polysaccharide (and the dispersion) to the substrate. Moreover, the polysaccharide (and the dispersion) may be adhered to the substrate by dipping thus manufactured plug (tow bundle (or rod)) in polysaccharide (and the dispersion).

[0122] Among these methods, the method (ii) of spraying or sparging the substrate with the dispersion is preferred. In such a method, particularly, in the case where the substrate is a fibrous material (for example, a substrate having a filter rod structure), the polysaccharide (and the medium) can be conveniently and efficiently contained in the substrate (or in a dipping part of the substrate).

[0123] The treatment with the dispersion may be conducted against a part or all of the substrate. In particular, a substrate having a filter rod shape ensures adhesion of the polysaccharide to the bloomed filter rod by disposing or setting the dispersion as a part of an apparatus for adding a common plasticizer and an activated carbon for filter rod (e.g., the plasticizer such as triacetin) in the filter rod maker. In this case, it is not necessary to wholly coat the rod with the dispersion. Moreover, in the dipping method (i), at least the whole surface of the substrate (or the dipping part of the substrate) (preferably the whole surface and inside of the dipping part of the substrate) may be adhesively treated with the solution of the polysaccharide.

[0124] In the dipping method (i), the dipping time (or treatment time) may be selected depending on the embodiment of the polysaccharide or the content thereof, and may be, for example, not shorter than 0.001 second (for example, about 0.001 second to 24 hours), preferably about 0.005
second to 1 hour, and more preferably about 0.01 second to 30 minutes. Industrially, the dipping time may be, for example, not shorter than 0.001 second (for example, not shorter than 0.003 second), preferably about 0.003 to 30 seconds, and more preferably about 0.005 to 15 seconds.

Incidentally, the substrate adhesively treated with the medium is usually dried. By such drying, volatile components such as the volatile medium (e.g., water, and an alkanol) may be completely removed from the substrate, or may partly or wholly reside in the substrate. By suitably adjusting such drying condition, the content of the medium to be left in the substrate can be adjusted.

The drying manner may be selected depending on the species of the medium (e.g., the volatile polar solvent, and the wetting polar solvent), the amount of the medium to be left, or others, and may be sun drying or air drying, and may be usually carried out by a dryer (e.g., a dryer which can reduce pressure (such as a vacuum dryer), and a hot air dryer).

The drying may be carried out under a room temperature (for example, about 15 to 25°C), or under a warming temperature (for example, about 40 to 200°C, preferably about 45 to 180°C, and more preferably about 50 to 150°C). Moreover, the drying may be conducted under an atmospheric pressure or a reduced pressure. The drying time may be, depending on the drying temperature, the drying pressure, the species of the medium, or other conditions. For example, the drying time may be not shorter than 1 minute (e.g., about 3 minutes to 24 hours), preferably about 5 minutes to 18 hours (e.g., 10 minutes to 12 hours), more preferably about 20 minutes to 10 hours (e.g., about 30 minutes to 8 hours).

Cigarette Filter and Cigarette

The cigarette filter material of the present invention is useful for constituting a cigarette filter. In the cigarette filter, the cigarette filter material of the present invention may be used singly or in combination depending on the shape thereof. The cigarette filter may comprise the cigarette filter material of the present invention and other cigarette filter material [for example, a granulated cigarette filter material coating-treated and the fibrous material (e.g., a fibrous material which is not coating-treated)]. For example, the cigarette filter of the present invention may constitute at least one part of a cigarette filter divided into a plurality of parts (e.g., a dual, or a triple), for example, one part of the dual, or both parts of the triple. Other cigarette filter material may constitute the remaining parts (for example, the other part of the dual, or the intermediate part of the triple). Examples of other cigarette filter material may include a filter material composed of a part having a dermatin containing a particulate substance (such as an activated carbon) and the other part having a natural.

The cigarette filter may be formed by a conventional method depending on the structure of the substrate or the filter. For example, the filter having a filter rod may be bloomed, then the bloomed filter may be applied with a conventional plasticizer (such as triacetin), and then the filter rod may be compacted at a given diameter and wrapped by paper using a filter rod maker. Moreover, the filter not having a filter rod may be produced by a conventional method, for example, (a) a method of filling a fibrous, powdery or other filter material directly in a metal mold for forming filter rod to give a filter plug, (b) a method of filling the filter material in a space of a pre-formed filter plug, and other methods.

The cigarette filter of the present invention comprising the cigarette filter material can efficiently reduce (or remove) an aldehyde (e.g., formaldehyde) while maintaining a palatable component (such as nicotine or tar or both) at a high level. Therefore, the present invention also includes a method for reducing an amount of an aldehyde (particularly, formaldehyde) in mainstream smoke, wherein the method comprises forming the filter from the cigarette filter material [more specifically, a method for reducing the amount of the aldehyde (particularly, formaldehyde) while maintaining the amounts of nicotine and tar in mainstream smoke].

For example, the retention or retention rate of formaldehyde (or formaldehyde retention) of the cigarette filter (in terms of weight) may be selected from the range of not more than 90% (e.g., about 0 to 88%), and may be for example, not more than 85% (e.g., about 3 to 80%), preferably not more than 70% (e.g., about 5 to 65%), more preferably not more than 65% (e.g., about 10 to 60%), and particularly not more than 50% (e.g., about 15 to 45%). Such a cigarette filter can reduce formaldehyde at a high level.

Moreover, the nicotine retention (in terms of weight) of the cigarette filter and the tar retention (in terms of weight) thereof may be selected from the range of not less than 50% (e.g., about 55 to 100%), and are not less than 60% (e.g., about 65 to 100%), preferably not less than 70% (e.g., about 75 to 99%), more preferably not less than 75% (e.g., about 80 to 98%), and particularly not less than 80% (e.g., about 85 to 97%).

In particular, the nicotine retention (in terms of weight) of the cigarette filter may be selected from the range of not less than 60% (e.g., about 65 to 100%), and may be, for example, not less than 70% (e.g., about 75 to 99%), preferably not less than 80% (e.g., about 82 to 98%), and more preferably not less than 85% (e.g., about 88 to 95%). Moreover, the tar retention (in terms of weight) of the cigarette filter may be selected from the range of not less than 50% (e.g., about 55 to 100%), and may be, for example, not less than 55% (e.g., about 60 to 100%), preferably not less than 65% (e.g., about 70 to 99.9%), more preferably not less than 70% (e.g., about 75 to 99.5%), and particularly not less than 75% (e.g., about 80 to 99.5%).

Incidentally, the retention (formaldehyde retention, nicotine retention, tar retention) may be measured as the basis for the amount of component (formaldehyde, nicotine, or tar) in smoke passing through a cigarette filter comprising a cigarette filter material before coating treatment. That is, the "retention" is expressed by the following formula when "X" represents an amount of formaldehyde (or nicotine or tar) in smoke passing through a cigarette filter comprising the untreated cigarette filter material (or the cigarette filter material before coating treatment) under given conditions (e.g., flow volume, time period, and number of times) and "X'" represents an amount of formaldehyde (or nicotine or tar) in smoke passing through a treated cigarette filter in the same conditions as the case of the measurement of the amount of "X'."

Retention(%)=(YZX)x100
Moreover, in the present invention, since the substrate treated with the dispersion containing the polysaccharide and the medium is employed, the substrate can be incorporated into the cigarette filter without increase of the pressure drop of the cigarette filter. The cigarette filter of the present invention therefore has draw resistance suitable to smoke. The pressure drop of the cigarette filter may be selected from the range of 150 to 600 mmWG (water gage) on the basis that air is passed at a flow volume of 17.5 ml/sec. through a cigarette filter having a length of 120 mm and a circumference of 24.5x0.2 mm, and may be, for example, about 180 to 500 mmWG, preferably about 200 to 450 mmWG (e.g., about 220 to 400 mmWG), and more preferably about 250 to 350 mmWG.

Moreover, the cigarette of the present invention comprises the cigarette filter (or the cigarette filter material). The site to be disposed of the cigarette filter material is not particularly limited to a specific one. In a cigarette shaped in the form of a rod by a wrapper, the cigarette filter is often disposed in the mouthpieth or between the mouthpieth and paper-wrapped cigarette. Incidentally, the periphery of the cross section of the cigarette corresponds to that of the cross section of the filter in many cases, and may be usually about 15 to 30 mm, preferably about 17 to 27 mm.

INDUSTRIAL APPLICABILITY

The cigarette filter material of the present invention is useful for constituting a cigarette filter (and a cigarette). In smoking, such a cigarette filter (and the cigarette) of the present invention can maintain the appropriate pressure drop (or draw resistance) while holding a palatable component such as nicotine or tar, and therefore ensures to selectively reduce (or remove) an aldehyde (e.g., formaldehyde), which is a harmful substance on the human body, without deterioration of taste and palatability (aroma and palatability) and of a sense of satisfaction in smoking.

EXAMPLES

The following examples are intended to describe this invention in further detail and should by no means be interpreted as defining the scope of the invention. Incidentally, in the following Examples and Comparative Examples, each property (a draw resistance, an amount of nicotine, an amount of tar, and an amount of formaldehyde) were measured by using a commercially available cigarette [Peace Light Box (Registered Trademark No. 2122839) manufactured by Japan Tobacco, Inc.] in accordance with the following methods.

[Draw Resistance]

The draw resistance of the above-mentioned cigarette [Peace Light Box (Registered Trademark No. 2122839) manufactured by Japan Tobacco, Inc.] was directly measured by using a cigarette filter sample containing the leaf part of the cigarette. In the sample, the length of the filter was 25 mm and the periphery thereof was about 25 mm. The draw resistance was determined as a pressure drop measured by using an automatic pressure drop-measuring apparatus (manufactured by Filtron Instruments & Automation Ltd., FTS300) when the flow volume of air was 17.5 ml/second.

[Amount of Nicotine and Amount of Tar]

The smoking was conducted by using a cigarette filter sample with the use of a piston-type automatic smok-
A piece (that is, the filter part (110 mg) having a length of 14 mm) was used to plug the glass tube. Thereafter, the connect part of the glass tube to the filter was also sealed up by wrapping a sealing tape around the connect part.

Accordingly, the length of the filter comprising the cellulose diacetate crimped fiber tow was 25 mm. Moreover, the chitosan powder was used in the extended part (9 mm) between the filters. The filling amount of the chitosan particle was 20 mg per cigarette.

Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. Then, the reducing rate of nicotine, that of tar and that of formaldehyde were calculated. These results are shown in Table 1.

Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that the chitosan particle was not filled.

Comparative Example 2

In Comparative Example 2, an activated carbon commonly used for a cigarette filter was employed. As the activated carbon, a crushed carbon “CW350FS” was used manufactured by Futamura Chemical Co., Ltd. The crushed carbon was passed through a sieve to collect a particle passing through a 30 mesh sieve and not passing through a 50 mesh sieve. In the same manner as Comparative Example 1, the activated carbon was filled in the extended part between the filters. The filling amount of the activated carbon was 20 mg per cigarette.

Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. Then, the reducing rate of nicotine, that of tar and that of formaldehyde were calculated. These results are shown in Table 1.

Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that the activated carbon was not filled.

Example 1

In the same manner as Comparative Example 1, in a filter body (25 mm) of a cellulose diacetate crimped fiber tow, a part of the filter body (14 mm from the end) was cut with a razor. To the obtained longer piece (that is, a piece containing a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the remaining filter (11 mm) was promptly covered with the glass tube. Then, the cigarette and glass tube were united with a sealing tape.

The cut shorter piece (that is, the filter part having a length of 14 mm) was dipped (or immersed) in a chitosan-water dispersion for 10 minutes, where the chitosan-water dispersion was a dispersion containing 2% by weight of chitosan (having a degree of deacetylation of 95%) (that is, a solution obtained by diluting “Daichitosan FP-slurry” (manufactured by Daicelchisika Color & Chemicals Mfg. Co., Ltd.) to three-fold in volume with water). After dipping, the filter part was put in a vacuum dryer, and dried for 5 hours at a temperature of 22°C and under a pressure of 80 mmHg. The amounts of chitosan and water adhered to the resulting filter part were 13 mg and 71 mg, respectively. The specific surface area of chitosan adhered to the substrate was not more than 0.1 m² (the minimum limit of measurement: not more than 0.12 m²) per gram of chitosan.

The dried filter part having a length of 14 mm was used to plug the glass tube so that the empty space (9 mm) of the glass tube remained. Then, the connect part of the glass tube to the dried filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter comprising the cellulose diacetate crimped fiber tow was 25 mm.

Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The retention of nicotine was 98%, that of tar was 100%, the reducing rate of formaldehyde was 19% (that is, the retention was 81%), and the draw resistance was 162 mmWG.

Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that the cut filter piece (14 mm) was not treated.

Example 2

In the same manner as Comparative Example 1, in a filter body (25 mm) of a cellulose diacetate crimped fiber tow, a part of the filter body (14 mm from the end) was cut with a razor. To the obtained longer piece (that is, a piece containing a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the remaining filter (11 mm) was promptly covered with the glass tube. Then, the cigarette and glass tube were united with a sealing tape.

The cut shorter piece (that is, the filter part having a length of 14 mm) was dipped in a chitosan-water dispersion for 10 minutes, where the chitosan-water dispersion was a dispersion containing 2% by weight of chitosan (having a degree of deacetylation of 95%) (that is, a solution obtained by diluting “Daichitosan FP-slurry” (manufactured by Daicelchisika Color & Chemicals Mfg. Co., Ltd.) to three-fold in volume with water). After dipping, the filter part was put in a vacuum dryer, and dried for 5 hours at a temperature of 22°C and under a pressure of 80 mmHg. The amounts of chitosan and water adhered to the resulting filter part were 13 mg and 71 mg, respectively. The specific surface area of chitosan adhered to the substrate was not more than 0.1 m² (the minimum limit of measurement: not more than 0.12 m²) per gram of chitosan.

The dried filter part having a length of 14 mm was used to plug the glass tube so that the empty space (9 mm) of the glass tube remained. Then, the connect part of the glass tube to the dried filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter comprising the cellulose diacetate crimped fiber tow was 25 mm.

Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The retention of nicotine was 83%, that of tar was 100%, the reducing rate of formaldehyde was 45% (that is, the retention was 55%), and the draw resistance was 179 mmWG.

Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control
sample was made in the same manner as the above-mentioned method except that the cut filter piece (14 mm) was not treated.

Example 3

[0168] In the same manner as Comparative Example 1, in a filter body (25 mm) of a cellulose diacetate crimped fiber tow, a part of the filter body (14 mm from the end) was cut with a razor. To the obtained longer piece (that is, a piece containing a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the remaining filter (11 mm) was promptly covered with the glass tube. Then, the cigarette and glass tube were united with a sealing tape.

[0169] The cut shorter piece (that is, the filter part having a length of 14 mm) was dipped in a chitosan-water dispersion for 10 minutes, where the chitosan-water dispersion was a dispersion containing 2% by weight of chitosan (having a degree of deacetylation of 95%) (that is, a solution obtained by diluting “Daichitosan FP-slurry” (manufactured by Daichiseika Color & Chemicals Mfg. Co., Ltd.) to three-fold in volume with water). After dipping, the filter part was put in a vacuum dryer, and dried for 6 hours and 15 minutes at a temperature of 22°C and under a pressure of 80 mmHg. The amounts of chitosan and water adhered to the resulting filter part were 13 mg and 19 mg, respectively. The specific surface area of chitosan adhered to the substrate was not more than 1 m² (the minimum limit of measurement: not more than 0.92 m²) per gram of chitosan.

[0170] The dried filter part having a length of 14 mm was used to plug the glass tube so that the empty space (9 mm) of the glass tube remained. Then, the connect part of the glass tube to the dried filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter comprising the cellulose diacetate crimped fiber tow was 25 mm.

[0171] Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The retention of nicotine was 99%, that of tar was 97%, the reducing rate of formaldehyde was 64% (that is, the retention was 64%), and the draw resistance was 168 mmWG.

[0172] Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that the cut filter piece (14 mm) was not treated.

Example 4

[0173] In the same manner as Comparative Example 1, in a filter body (25 mm) of a cellulose diacetate crimped fiber tow, a part of the filter body (14 mm from the end) was cut with a razor. To the obtained longer piece (that is, a piece containing a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the remaining filter (11 mm) was promptly covered with the glass tube. Then, the cigarette and glass tube were united with a sealing tape.

[0174] The cut shorter piece (that is, the filter part having a length of 14 mm) was dipped in a dispersion for 10 minutes, where the dispersion comprised a chitosan-water dispersion containing 2% by weight of chitosan (having a degree of deacetylation of 95%) (that is, a solution obtained by diluting “Daichitosan FP-slurry” (manufactured by Daichiseika Color & Chemicals Mfg. Co., Ltd.) to three-fold in volume with water) and 1% by weight of glycerin. After dipping, the filter part was put in a vacuum dryer, and dried for 8 hours and 30 minutes at a temperature of 22°C and under a pressure of 80 mmHg. The amounts of chitosan and glycerin adhered to the resulting filter part were 13 mg and 7 mg, respectively. The specific surface area of chitosan adhered to the substrate was not more than 1 m² (the minimum limit of measurement: not more than 0.92 m²) per gram of chitosan.

[0175] The dried filter part having a length of 14 mm was used to plug the glass tube so that the empty space (9 mm) of the glass tube remained. Then, the connect part of the glass tube to the dried filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter comprising the cellulose diacetate crimped fiber tow was 25 mm.

[0176] Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The retention of nicotine was 96%, that of tar was 86%, the reducing rate of formaldehyde was 51% (that is, the retention was 49%), and the draw resistance was 158 mmWG.

[0177] Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that the cut filter piece (14 mm) was not treated.

Example 5

[0178] In the same manner as Comparative Example 1, in a filter body (25 mm) of a cellulose diacetate crimped fiber tow, a part of the filter body (14 mm from the end) was cut with a razor. To the obtained longer piece (that is, a piece containing a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the remaining filter (11 mm) was promptly covered with the glass tube. Then, the cigarette and glass tube were united with a sealing tape.

[0179] The cut shorter piece (that is, the filter part having a length of 14 mm) was dipped in a dispersion for 10 minutes, where the dispersion comprised a chitosan-water dispersion containing 2% by weight of chitosan (having a degree of deacetylation of 95%) (that is, a solution obtained by diluting “Daichitosan FP-slurry” (manufactured by Daichiseika Color & Chemicals Mfg. Co., Ltd.) to three-fold in volume with water) and 4% by weight of glycerin. After dipping, the filter part was put in a vacuum dryer, and dried for 8 hours and 30 minutes at a temperature of 22°C and under a pressure of 80 mmHg. The amounts of chitosan and glycerin adhered to the resulting filter part were 14 mg and 27 mg, respectively. The specific surface area of chitosan adhered to the substrate was not more than 1 m² (the minimum limit of measurement: not more than 0.92 m²) per gram of chitosan.

[0180] The dried filter part having a length of 14 mm was used to plug the glass tube so that the empty space (9 mm) of the glass tube remained. Then, the connect part of the glass tube to the dried filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter comprising the cellulose diacetate crimped fiber tow was 25 mm.

[0181] Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the
amount of formaldehyde were measured. The retention of nicotine was 94%, that of tar was 93%, the reducing rate of formaldehyde was 72% (that is, the retention was 28%), and the draw resistance was 162 mmWG.

[0182] Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that the cut filter piece (14 mm) was not treated.

Example 6

[0183] In the same manner as Comparative Example 1, in a filter body (25 mm) of a cellulose diacetate crimped fiber tow, a part of the filter body (14 mm from the end) was cut with a razor. To the obtained longer piece (that is, a piece containing a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the remaining filter (11 mm) was promptly covered with the glass tube. Then, the cigarette and glass tube were united with a sealing tape.

[0184] The cut shorter piece (that is, the filter part having a length of 14 mm) was dipped in a chitosan-ethanol dispersion for 10 minutes, where the chitosan-ethanol dispersion (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.) contained 6% by weight of chitosan (having a degree of deacetylation of 90%). After dipping, the filter part was put in a vacuum dryer, and dried for 5 hours at a temperature of 22°C and under a pressure of 80 mmHg. The amount of chitosan adhered to the resultant filter part was 30 mg. The specific surface area of chitosan adhered to the substrate was 9.8 m² per gram of chitosan.

[0185] The dried filter part having a length of 14 mm was used to plug the glass tube so that the empty space (9 mm) of the glass tube remained. Then, the connect part of the glass tube to the dried filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter comprising the cellulose diacetate crimped fiber tow was 25 mm.

[0186] Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The retention of nicotine was 96%, that of tar was 87%, the reducing rate of formaldehyde was 66% (that is, the retention was 34%), and the draw resistance was 186 mmWG.

[0187] Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that the cut filter piece (14 mm) was not treated.

Example 7

[0188] In the same manner as Comparative Example 1, in a filter body (25 mm) of a cellulose diacetate crimped fiber tow, a part of the filter body (14 mm from the end) was cut with a razor. To the obtained longer piece (that is, a piece containing a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the remaining filter (11 mm) was promptly covered with the glass tube. Then, the cigarette and glass tube were united with a sealing tape.

[0189] The cut shorter piece (that is, the filter part having a length of 14 mm) was dipped in a dispersion for 10 minutes, where the dispersion comprised a chitosan-ethanol dispersion (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.) containing 6% by weight of chitosan (having a degree of deacetylation of 90%), and 3% by weight of glycerin. After dipping, the filter part was put in a vacuum dryer, and dried for 5 hours at a temperature of 22°C and under a pressure of 80 mmHg. The amounts of chitosan and glycerin adhered to the resulting filter part were 30 mg and 15 mg, respectively. The specific surface area of chitosan adhered to the substrate was 7.5 m² per gram of chitosan.

[0190] The dried filter part having a length of 14 mm was used to plug the glass tube so that the empty space (9 mm) of the glass tube remained. Then, the connect part of the glass tube to the dried filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter comprising the cellulose diacetate crimped fiber tow was 25 mm.

[0191] Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The retention of nicotine was 88%, that of tar was 76%, the reducing rate of formaldehyde was 77% (that is, the retention was 23%), and the draw resistance was 182 mmWG.

[0192] Incidentally, for evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that the cut filter piece (14 mm) was not treated.

Example 8

[0193] A chitosan-triacetin dispersion as a plasticizer (containing 40% by weight of chitosan having a degree of deacetylation of 90%) (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.) was impregnated to a cellulose diacetate crimped fiber tow having a filament denier of 2.2 and a total denier of 40,000 (manufactured by Daicel Chemical Industries, Ltd.), and the tow was bundled. The bundled tow was rolled up by an automatic rolling up apparatus to give a cigarette filter rod having a length of 100 mm and an outer diameter of 8 mm. The resulting rod was cut into quarters in the direction of the long direction to obtain filter chips each having a length of 25 mm. The amounts of chitosan and triacetin adhered to the 25 mm filter chip were 16 mg and 23.8 mg, respectively. The specific surface area of chitosan adhered to the substrate was 6.8 m² per gram of chitosan.

[0194] A filter body (25 mm) of a cellulose diacetate crimped fiber tow of a commercially available cigarette [Peace Light Box (Registered Trademark No. 2122839) manufactured by Japan Tobacco, Inc.]] was cut with a razor. To the obtained longer piece (that is, a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the inserted part was 11 mm. Then, the cigarette and glass tube were united with a sealing tape. The empty space (9 mm) of the glass tube was stopped with the filter chip made by using the chitosan-triacetin dispersion as a plasticizer. Then, the connect part of the glass tube to the filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter of the cellulose diacetate crimped fiber tow was 25 mm.

[0195] Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The retention of
nicotine was 93%, that of tar was 97%, the reducing rate of formaldehyde was 38% (that is, the retention was 62%), and the draw resistance was 164 mmWG.

Example 9

A mixture of 100 parts by weight of a chitosan-triacetin dispersion as a plasticizer (containing 40% by weight of chitosan having a degree of deacetylation of 90%) (manufactured by Daiichisekiwa Color & Chemicals Mfg. Co., Ltd.) and 10% by weight of glycerin was impregnated to a cellulose diacetate crimped fiber tow having a filament denier of 2.2 and a total denier of 40,000 (manufactured by Daicel Chemical Industries, Ltd.), and the tow was bundled. The bundled tow was rolled up by an automatic rolling up apparatus to give a cigarette filter rod having a length of 100 mm and an outer diameter of 8 mm. The resulting rod was cut into quarters in the direction of the long direction to obtain filter chips each having a length of 25 mm. The amounts of chitosan, triacetin and glycerin adhered to the 25 mm filter chip were 15 mg, 22.5 mg and 2 mg, respectively. The specific surface area of chitosan adhered to the substrate was 3.4 m² per gram of chitosan.

A filter body (25 mm) of a cellulose diacetate crimped fiber tow of a commercially available cigarette [Peace Light Box (Registered Trademark No. 2122839) manufactured by Japan Tobacco, Inc.] was cut with a razor. To the obtained longer piece (that is, a tobacco leaf-filled part), was inserted a glass tube having a length of 20 mm and an internal diameter of 8 mm in order that the inserted part was 11 mm. Then, the cigarette and glass tube were united with a sealing tape. The empty space (9 mm) of the glass tube was stuffed with the filter chip made by using the chitosan-triacetin dispersion as a plasticizer. Then, the connect part of the glass tube to the filter was also sealed up by wrapping a sealing tape around the part. Accordingly, the length of the filter of the cellulose diacetate crimped fiber tow was 25 mm.

Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The reducing rate of nicotine was 93%, that of tar was 97%, the reducing rate of formaldehyde was 38% (that is, the retention was 62%), and the draw resistance was 168 mmWG.

Example 10

A mixture of 100 parts by weight of a chitosan-triacetin dispersion as a plasticizer (containing 40% by weight of chitosan having a degree of deacetylation of 90%) (manufactured by Daiichisekiwa Color & Chemicals Mfg. Co., Ltd.) and 10% by weight of glycerin was impregnated to a cellulose diacetate crimped fiber tow having a filament denier of 2.2 and a total denier of 40,000 (manufactured by Daicel Chemical Industries, Ltd.), and the tow was bundled. The bundled tow was rolled up by an automatic rolling up apparatus to give a cigarette filter rod having a length of 100 mm and an outer diameter of 8 mm. The resulting rod was cut into quarters in the direction of the long direction to obtain filter chips each having a length of 25 mm. The amounts of chitosan, triacetin and glycerin adhered to the 25 mm filter chip were 15.5 mg, 23.3 mg and 2.1 mg, respectively. The specific surface area of chitosan adhered to the substrate was 3.2 m² per gram of chitosan.

Concerning this cigarette filter sample, the draw resistance, the amount of nicotine, the amount of tar, and the amount of formaldehyde were measured. The reducing rate of nicotine was 5%, that of tar was 2%, that of formaldehyde was 68%, and the draw resistance was 172 mmWG.

For evaluating the reducing rate of nicotine, that of tar and that of formaldehyde, a control sample was made in the same manner as the above-mentioned method except that triacetin was used as a plasticizer.

Example 10

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Chitosan (mg)</th>
<th>Specific surface area (m²/g)</th>
<th>Content of medium (mg)</th>
<th>Amount of hydroxyl group in medium to 1 mol of glucose unit of chitosan (mol)</th>
<th>Draw resistance (mmWG)</th>
<th>Reducing rate of nicotine (%)</th>
<th>Reducing rate of tar (%)</th>
<th>Reducing rate of formaldehyde (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>147</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Corn. Ex. 1</td>
<td>20</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>172</td>
<td>18</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Corn. Ex. 2</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>163</td>
<td>37</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Ex. 1</td>
<td>13 less than 1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>162</td>
<td>0</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Ex. 2</td>
<td>13 less than 1 water: 71</td>
<td>48.9</td>
<td>179</td>
<td>17</td>
<td>0</td>
<td>11</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td>Ex. 3</td>
<td>14 less than 1 water: 19</td>
<td>12.1</td>
<td>168</td>
<td>11</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Ex. 4</td>
<td>13 less than 1 glycerin: 7</td>
<td>2.82</td>
<td>158</td>
<td>1</td>
<td>0</td>
<td>14</td>
<td>1</td>
<td>51</td>
</tr>
<tr>
<td>Ex. 5</td>
<td>14 less than 1 glycerin: 27</td>
<td>10.1</td>
<td>162</td>
<td>6</td>
<td>0</td>
<td>7</td>
<td>7</td>
<td>72</td>
</tr>
</tbody>
</table>
**TABLE 1-continued**

<table>
<thead>
<tr>
<th></th>
<th>Chitosan (mg)</th>
<th>Specific surface area (m²/g)</th>
<th>Content of medium (mg)</th>
<th>Amount of hydroxyl group in medium to 1 mol of glucose unit of chitosan (mol)</th>
<th>Draw resistance (mmWG)</th>
<th>Reducing rate of nicotine (%)</th>
<th>Reducing rate of tar (%)</th>
<th>Reducing rate of formaldehyde (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. 6</td>
<td>30</td>
<td>9.8</td>
<td>—</td>
<td>—</td>
<td>186</td>
<td>4</td>
<td>13</td>
<td>66</td>
</tr>
<tr>
<td>Ex. 7</td>
<td>30</td>
<td>7.5</td>
<td>glycerin: 15</td>
<td>5.60</td>
<td>182</td>
<td>12</td>
<td>24</td>
<td>77</td>
</tr>
<tr>
<td>Ex. 8</td>
<td>16</td>
<td>6.8</td>
<td>triacetin: 23.8</td>
<td>—</td>
<td>164</td>
<td>7</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>Ex. 9</td>
<td>15</td>
<td>3.4</td>
<td>glycerin: 2</td>
<td>0.81</td>
<td>168</td>
<td>10</td>
<td>9</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>triacetin: 22.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>triacetin: 23.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>dioctetin: 7.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex. 10</td>
<td>15.5</td>
<td>3.2</td>
<td>—</td>
<td>172</td>
<td>5</td>
<td>2</td>
<td>68</td>
<td></td>
</tr>
</tbody>
</table>

1. A cigarette filter material comprising a substrate and a polysaccharide having an amino group, wherein the polysaccharide is adhered to the substrate,

   wherein the substrate is treated with a dispersion comprising the polysaccharide and a medium, and the polysaccharide is dispersed in the form of a particle.

2. A cigarette filter material according to claim 1, wherein the material has a filter rod structure and the polysaccharide is a chitosan.

3. A cigarette filter material according to claim 2, wherein, the dispersion comprises the polysaccharide having an average particle size of 0.5 to 50 μm, and the medium comprises at least one member selected from the group consisting of a hydroxyl group-containing solvent and a plasticizer for the substrate.

4. A cigarette filter material according to claim 3, wherein the hydroxyl group-containing solvent is at least one member selected from the group consisting of water and an alcohol, and the plasticizer for the substrate is a lower fatty acid ester of a polyol.

5. A cigarette filter material according to claim 1, wherein the medium contains a polyol as a humectant.

6. A cigarette filter material according to claim 5, wherein the polyol comprises at least one member selected from the group consisting of a C₂₃₋₅₃ alkanediol, a di- to tetraC₂₋₅ alkyleneglycol, and a C₃₋₁₀ alkanetriol.

7. A cigarette filter material according to claim 6, wherein the dispersion at least comprises a chitosan having a degree of deacetylation of not less than 70% and an average particle size of 1 to 20 μm, and a C₃₋₁₀ alkanetriol.

8. A cigarette filter material according to claim 7, wherein the adhering amount of the polysaccharide is 1 to 100 parts by weight relative to 100 parts by weight of the substrate.

9. A cigarette filter material according to claim 8, wherein the medium resides in the substrate.

10. A cigarette filter material according to claim 9, wherein the residual amount of the medium is 0.5 to 100 parts by weight relative to 100 parts by weight of the substrate.

11. A cigarette filter material according to claim 9, wherein the adhering amount of the polysaccharide is 1 to 80 parts by weight relative to 100 parts by weight of the substrate, and the residual amount of the medium is 5 to 400 parts by weight relative to 100 parts by weight of the polysaccharide.

12. A cigarette filter material according to claim 9, wherein the medium residing in the substrate at least comprises a polyol as a humectant, and the content of the polyol is 3 to 200 parts by weight relative to 100 parts by weight of the polysaccharide.

13. A process for producing a cigarette filter material recited in claim 1, which comprises treating a substrate with a dispersion, wherein the dispersion comprises a particulate polysaccharide having an amino group, and a medium.

14. A cigarette filter which is made of a cigarette filter material recited in claim 1.

15. (canceled)

16. A cigarette which comprises a cigarette filter recited in claim 14.

* * * * *