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(54) **TOBACCO SHEET FOR NON-COMBUSTION HEATING-TYPE FLAVOR INHALER AND METHOD FOR MANUFACTURING SAME, NON-COMBUSTION HEATING-TYPE FLAVOR INHALER, AND NON-COMBUSTION HEATING-TYPE FLAVOR INHALING SYSTEM**

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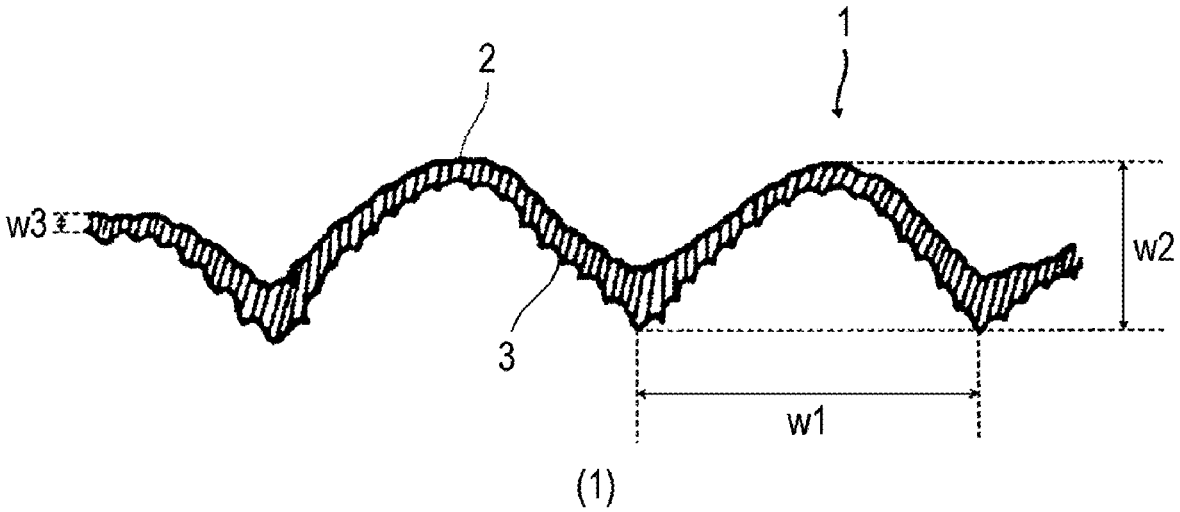
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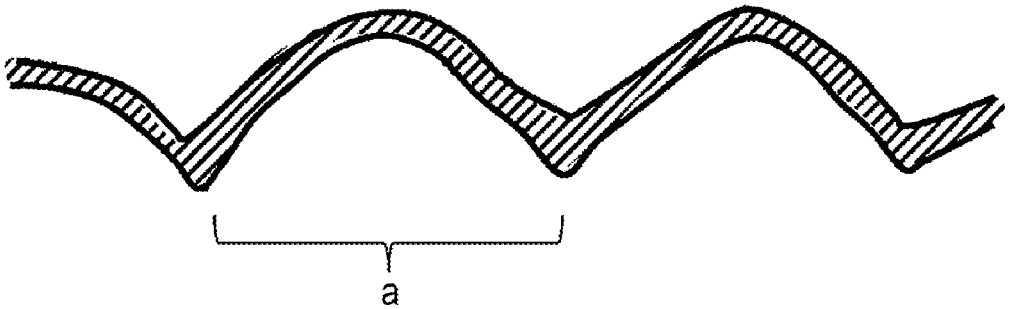
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(57) **ABSTRACT**

Provided is a tobacco sheet for a non-combustion heating-type flavor inhaler including a tobacco material, wherein a cross-section of the tobacco sheet in the thickness direction has a wavy shape.

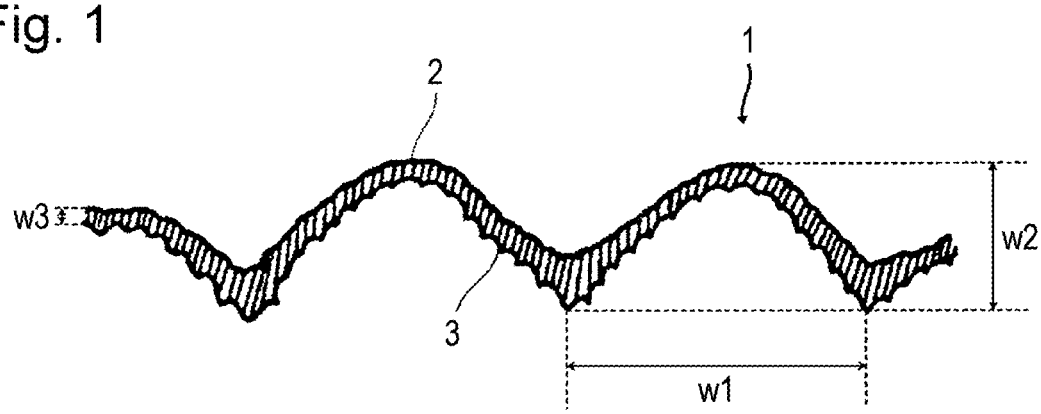


(1)

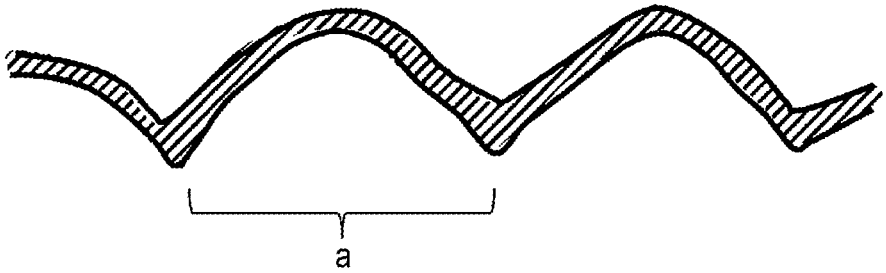


(2)

Fig. 1



(1)



(2)

Fig. 2

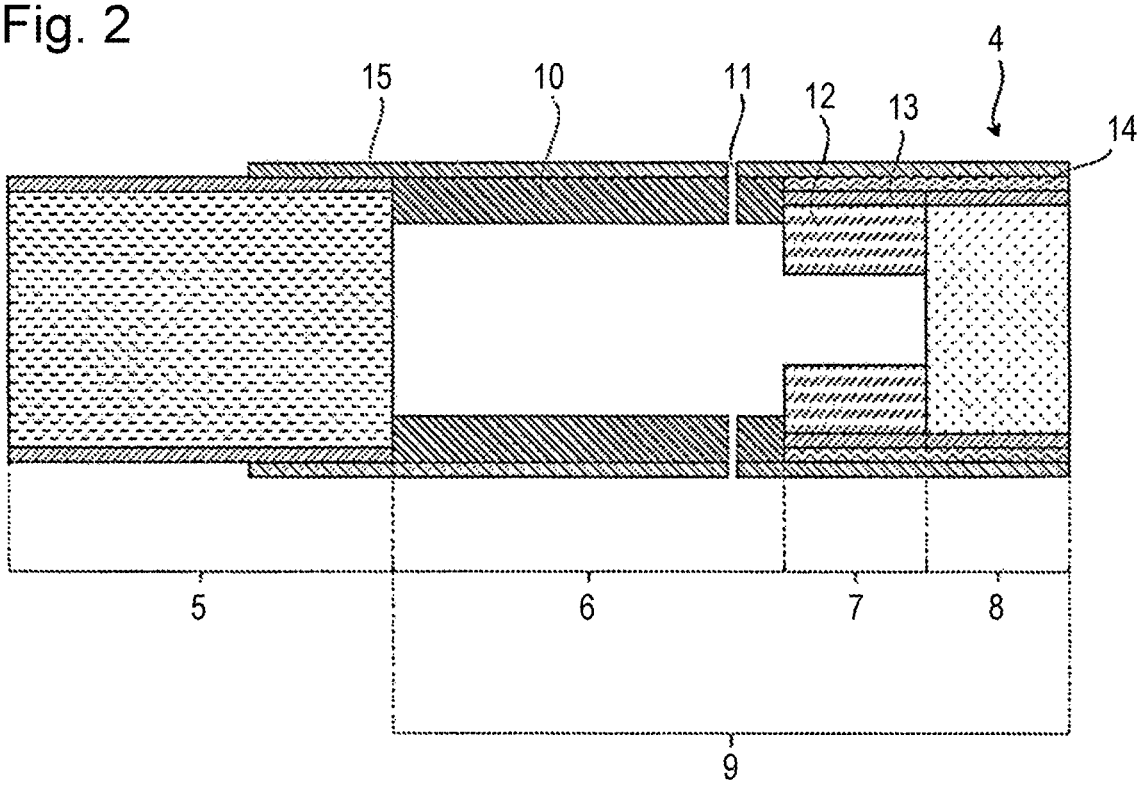
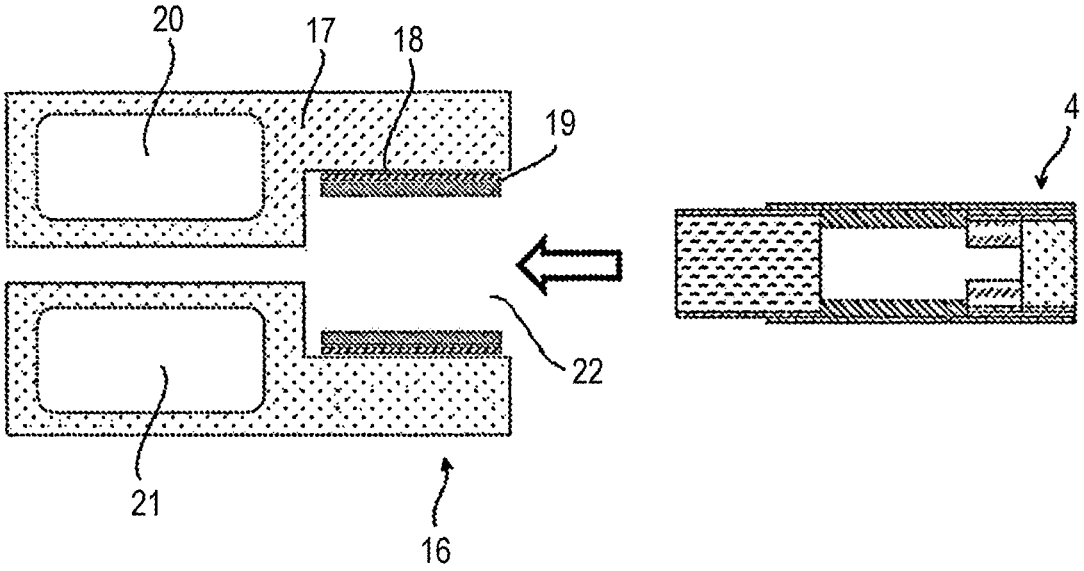


Fig. 3

(a)



(b)

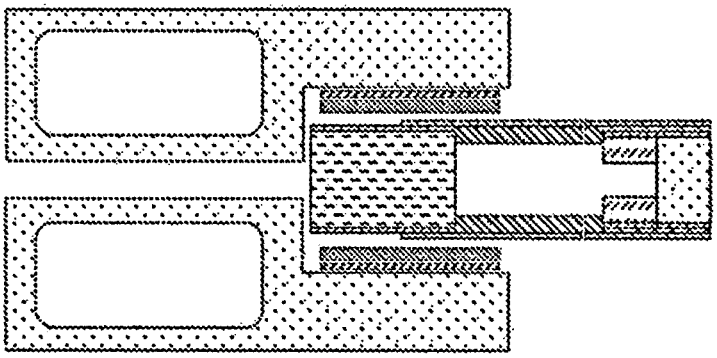
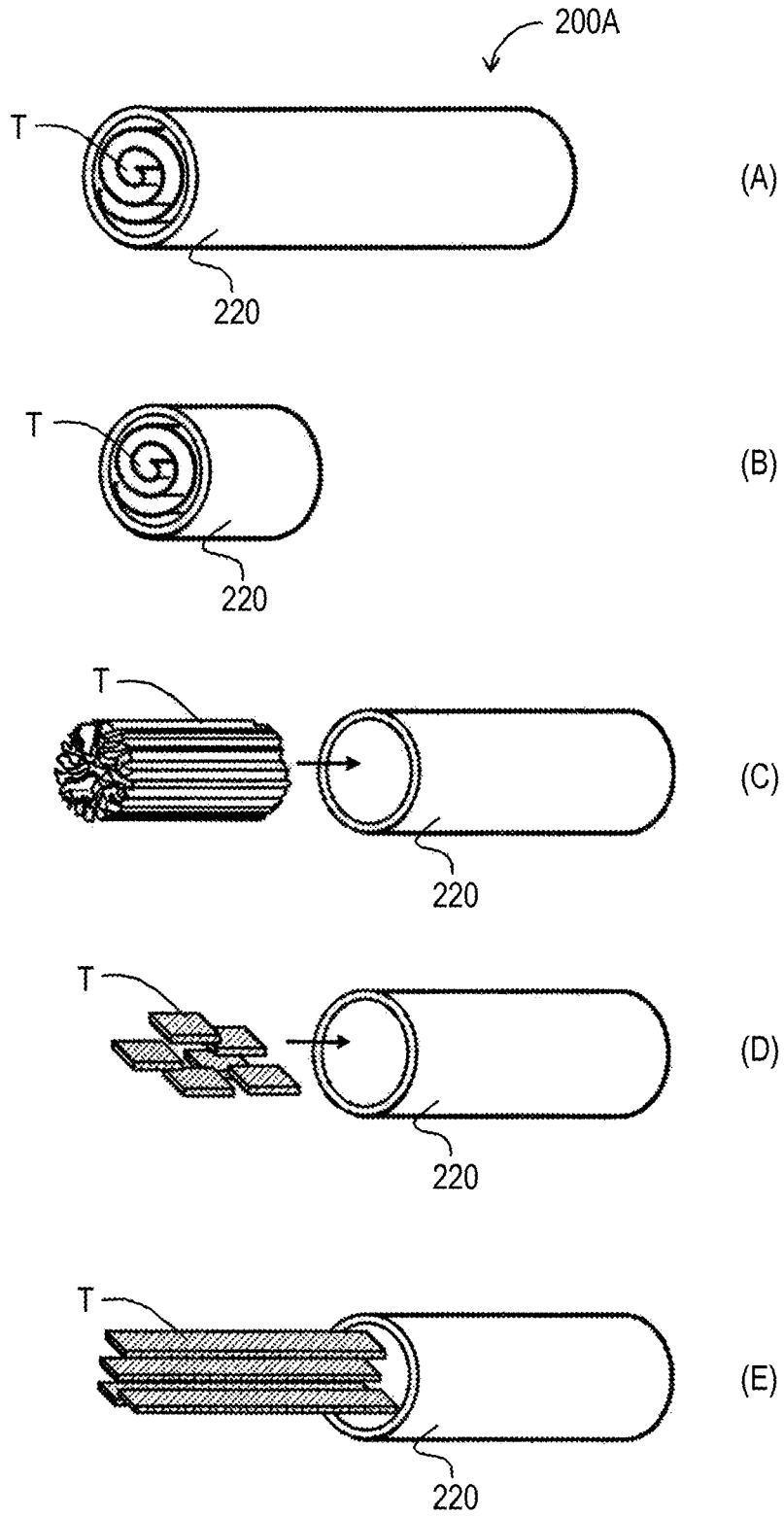


Fig. 4



TOBACCO SHEET FOR NON-COMBUSTION HEATING-TYPE FLAVOR INHALER AND METHOD FOR MANUFACTURING SAME, NON-COMBUSTION HEATING-TYPE FLAVOR INHALER, AND NON-COMBUSTION HEATING-TYPE FLAVOR INHALING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a Continuation of International Patent Application No. PCT/JP2022/036764 filed on Sep. 30, 2022, which contains subject matter related to PCT Application No. PCT/JP2021/036386 filed on Oct. 1, 2021, PCT Application No. PCT/JP2021/036387 filed on Oct. 1, 2021 and Japanese Patent Application No. 2021-170059 filed in the Japan Patent Office on Oct. 18, 2021, the entire contents of each are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to a tobacco sheet for a non-combustion heating-type flavor inhaler, a method for manufacturing the tobacco sheet, a non-combustion heating-type flavor inhaler, and a non-combustion heating-type flavor inhaling system.

BACKGROUND ART

[0003] In a combustion-type flavor inhaler (cigarette), a tobacco filler, including leaf tobacco or a tobacco sheet, is combusted to obtain a flavor. For example, Patent Literature 1 discloses a tobacco sheet for use in a combustion-type flavor inhaler. As an alternative to the combustion-type flavor inhaler, a non-combustion heating-type flavor inhaler has been proposed in which a flavor source, such as a tobacco sheet, is not combusted but heated to obtain a flavor. The heating temperature of a non-combustion heating-type flavor inhaler is lower than the combustion temperature of a combustion-type flavor inhaler and is approximately 400° C. or less, for example. Since a non-combustion heating-type flavor inhaler has a low heating temperature, an aerosol generator can be added to a flavor source in the non-combustion heating-type flavor inhaler from the perspective of increasing the amount of smoke. An aerosol generator is vaporized by heating and generates an aerosol. A user is supplied with the aerosol together with a flavor component, such as a tobacco component, and can obtain a sufficient flavor.

[0004] Such a non-combustion heating-type flavor inhaler can include, for example, a tobacco-containing segment filled with a tobacco sheet or the like, a cooling segment, and a filter segment. In relation to a heater, the tobacco-containing segment of the non-combustion heating-type flavor inhaler typically has a shorter axial length than the tobacco-containing segment of the combustion-type flavor inhaler. Thus, in the non-combustion heating-type flavor inhaler, the short tobacco-containing segment is filled with a large amount of tobacco sheet to ensure the amount of aerosol generated during heating. To fill the short segment with a large amount of tobacco sheet, the tobacco sheet in the non-combustion heating-type flavor inhaler typically has a low bulkiness or a high density. The bulkiness is a value indicating a volume of a predetermined mass of shredded tobacco sheets compressed at a certain pressure for a certain period.

CITATION LIST

Patent Literature

[0005] PTL 1: Japanese Examined Patent Application Publication No. 60-45914

SUMMARY OF INVENTION

Technical Problem

[0006] However, the present inventors have found that, in terms of the heating system, the heating capability of a heater, and aerosol generation, the use of a tobacco sheet with a low bulkiness (high density) increases the total heat capacity of the tobacco-containing segment and, depending on the heating method and the capability of a heater, the tobacco sheet filled in the tobacco-containing segment does not contribute sufficiently to aerosol generation. To solve this problem, it is conceivable to reduce the total heat capacity of the tobacco-containing segment.

[0007] To reduce the total heat capacity of the tobacco-containing segment, the present inventors have studied (1) reducing the specific heat of a tobacco raw material contained in a tobacco sheet and (2) using a tobacco sheet with a high bulkiness (low density). However, it is difficult to reduce the specific heat of the tobacco raw material itself in (1), and it was considered effective to reduce the total heat capacity of the tobacco-containing segment in (2). It is therefore desirable to develop a tobacco sheet with a high bulkiness (low density) suitable for use in a non-combustion heating-type flavor inhaler.

[0008] It is an object of the present invention to provide a tobacco sheet with a high bulkiness for a non-combustion heating-type flavor inhaler, a non-combustion heating-type flavor inhaler containing the tobacco sheet, and a non-combustion heating-type flavor inhaling system.

Solution to Problem

[0009] The present invention includes the following aspects.

[0010] Aspect 1

[0011] A tobacco sheet for a non-combustion heating-type flavor inhaler, wherein the tobacco sheet contains a tobacco raw material and has a wavy shape in a cross-section in a thickness direction.

Aspect 2

[0012] The sheet according to Aspect 1, wherein at least one of an arcuate curved surface present on a front surface and an arcuate curved surface present on a back surface of the sheet has a surface arithmetic mean surface roughness Sa in the range of 5 to 30 μm.

Aspect 3

[0013] The sheet according to Aspect 1 or 2, which is a press-formed sheet.

Aspect 4

[0014] The sheet according to any one of Aspects 1 to 3, containing a cellulose derivative with a degree of substitution of 0.65 or more.

Aspect 5

[0015] The sheet according to Aspect 4, wherein the degree of substitution is 0.7 or more.

Aspect 6

[0016] A non-combustion heating-type flavor inhaler including a tobacco-containing segment containing the tobacco sheet for a non-combustion heating-type flavor inhaler according to any one of Aspects 1 to 5.

Aspect 7

[0017] A non-combustion heating-type flavor inhaling system including:

[0018] the non-combustion heating-type flavor inhaler according to Aspect 6; and

[0019] a heating device for heating the tobacco-containing segment.

Aspect 8

[0020] A method for manufacturing the tobacco sheet according to any one of Aspects 1 to 5, including:

[0021] preparing a mixture containing the tobacco raw material, an aerosol generator, a first shaping agent, and a second shaping agent;

[0022] rolling the mixture to form a rolled product; and

[0023] pressing a rotary roll blade against the rolled product to cut the rolled product into a strip while imparting a wavy shape to the strip.

Advantageous Effects of Invention

[0024] The present invention can provide a tobacco sheet with a high bulkiness for a non-combustion heating-type flavor inhaler, a non-combustion heating-type flavor inhaler containing the tobacco sheet, and a non-combustion heating-type flavor inhaling system.

BRIEF DESCRIPTION OF DRAWINGS

[0025] FIG. **1** is a cross-sectional view in a thickness direction illustrating an example of a tobacco sheet according to the present embodiment.

[0026] FIG. **2** is a cross-sectional view of an example of a non-combustion heating-type flavor inhaler according to the present embodiment.

[0027] FIG. **3** is a cross-sectional view of an example of a non-combustion heating-type flavor inhaling system according to the present embodiment, illustrating (a) a state before a non-combustion heating-type flavor inhaler is inserted into a heating device and (b) a state in which the non-combustion heating-type flavor inhaler is inserted into the heating device and is heated.

[0028] FIG. **4** is a view of an embodiment of a tobacco segment.

DESCRIPTION OF EMBODIMENTS

[Tobacco Sheet for Non-Combustion Heating-Type Flavor Inhaler]

[0029] A tobacco sheet for a non-combustion heating-type flavor inhaler according to the present embodiment (hereinafter also referred to as a "tobacco sheet") contains a tobacco raw material and has a wavy shape in a cross-section in the thickness direction. Due to the wavy shape in the cross-section in the thickness direction, the tobacco sheet according to the present embodiment is bulky and has a high bulkiness. Thus, the tobacco sheet according to the present embodiment can be used to reduce the total heat capacity of a tobacco-containing segment, and the tobacco sheet filled in the tobacco-containing segment can contribute sufficiently to aerosol generation. Furthermore, the tobacco sheet according to the present embodiment preferably further contains an aerosol generator and one or two or more shaping agents, and the blending ratio of these is set in a predetermined range to further improve the bulkiness of the tobacco sheet.

(Shape of Tobacco Sheet)

[0030] The tobacco sheet according to the present embodiment has the wavy shape in the cross-section in the thickness direction. That is, the tobacco sheet according to the present embodiment cut in the thickness direction in one direction of an in-plane direction has a wavy shape in the cross-section. The one direction of the in-plane direction may be, for example, the longitudinal direction or the transverse direction of the tobacco sheet. Here, the "wavy shape" may be any vertically waved shape, and the wave crest may have a linear shape or a curved shape. Furthermore, the wave may be regular or irregular.

[0031] FIG. **1**(**1**) illustrates an example of a cross-sectional shape of the tobacco sheet according to the present embodiment in the thickness direction. A tobacco sheet **1** illustrated in FIG. **1**(**1**) has a wave **2** in a cross-section in the thickness direction. The width w**1** of the wave **2** is preferably, but not limited to, in the range of 0.1 to 10.0 mm. The height w**2** of the wave **2** is preferably, but not limited to, in the range of 0.1 to 5.0 mm. The tobacco sheet **1** preferably has a thickness w**3** in the range of 100 to 1000 μm. As illustrated in FIG. **1**(**1**), the wave **2** may have a serrated shape **3**. In the wave **2** with the serrated shape **3**, tips of the serrated shape can be brought into contact with each other in a mixture of the tobacco sheets and further form a void, thus further improving the bulkiness. The tobacco sheet according to the present embodiment may have any size in the in-plane direction and, for example, may have a length in the range of 5.0 to 40.0 mm and a width in the range of 0.5 to 2.0 mm. FIG. **1**(**2**) is described later.

(Tobacco Raw Material)

[0032] The tobacco raw material in the tobacco sheet according to the present embodiment may be any tobacco raw material containing a tobacco component and is, for example, a tobacco powder or a tobacco extract. The tobacco powder is, for example, leaf tobacco, midribs, residual stems, or the like. These may be used alone or in combination. These can be cut into a predetermined size and used as a tobacco powder. For the size of the tobacco powder, the cumulative 90% particle diameter (D90) in a volume-based

particle size distribution as measured by a dry laser diffraction method is preferably 200 μm or more, from the perspective of further improving the bulkiness. When the tobacco raw material is a tobacco powder, the tobacco powder content per 100% by mass of the tobacco sheet preferably ranges from 45% to 95% by mass, more preferably 50% to 93% by mass, still more preferably 60% to 85% by mass. The tobacco extract is, for example, a tobacco extract produced by coarsely grounding leaf tobacco, mixing and stirring the ground leaf tobacco with a solvent, such as water, to extract a water-soluble component from the leaf tobacco, and drying under vacuum and concentrating the resulting water extract.

(Aerosol Generator)

[0033] The tobacco sheet according to the present embodiment preferably further contains an aerosol generator from the perspective of increasing the amount of smoke during heating. The aerosol generator is, for example, glycerin, propylene glycol, 1,3-butanediol, or the like. These may be used alone or in combination.

[0034] When the tobacco sheet contains an aerosol generator, the aerosol generator content per 100% by mass of the tobacco sheet preferably ranges from 4% to 50% by mass. An aerosol generator content of 4% by mass or more can result in sufficient aerosol in terms of amount generated during heating. An aerosol generator content of 50% by mass or less can result in sufficient aerosol in terms of heat capacity generated during heating. The aerosol generator content more preferably ranges from 6% to 40% by mass, still more preferably 8% to 30% by mass, particularly preferably 10% to 20% by mass.

(Shaping Agent)

[0035] The tobacco sheet according to the present embodiment preferably further contains a shaping agent from the perspective of ensuring the shape. In particular, the tobacco sheet according to the present embodiment preferably further contains a first shaping agent and a second shaping agent from the perspective of sufficiently achieving both the aerosol generator retention capability and the wavy shape retention capability of the tobacco sheet. The first shaping agent and the second shaping agent may be of different types or may be of the same type but different in form. The first shaping agent is, for example, a polysaccharide, a protein, a synthetic polymer, or the like. The polysaccharide is, for example, a cellulose derivative or a naturally occurring polysaccharide.

[0036] The cellulose derivative is, for example, a cellulose ether, such as methyl cellulose, ethyl cellulose, hydroxyethyl cellulose, hydroxymethylethyl cellulose, hydroxypropyl cellulose, hydroxypropylmethyl cellulose, benzyl cellulose, trityl cellulose, cyanoethyl cellulose, carboxymethyl cellulose, carboxyethyl cellulose, or aminoethyl cellulose; an organic acid ester, such as cellulose acetate, cellulose formate, cellulose propionate, cellulose butyrate, cellulose benzoate, cellulose phthalate, or tosyl cellulose; a mineral acid ester, such as cellulose nitrate, cellulose sulfate, cellulose phosphate, or cellulose xanthate; or the like. The naturally occurring polysaccharide is, for example, a plant-derived polysaccharide, such as guar gum, tara gum, locust bean gum, tamarind seed gum, pectin, gum arabic, gum tragacanth, karaya gum, ghatti gum, arabinogalactan, flaxseed gum, cassia gum, psyllium seed gum, or *Artemisia* seed gum; an algae-derived polysaccharide, such as carrageenan, agar, alginic acid, a propylene glycol alginate ester, furcellaran, or a Colpomenia sinuosa extract; a microbial polysaccharide, such as xanthan gum, gellan gum, curdlan, pullulan, *Agrobacterium* succinoglycan, welan gum, Macrophomopsis gum, or rhamsan gum; a crustacean polysaccharide, such as chitin, chitosan, or glucosamine; a starch, such as starch, sodium starch glycolate, pregelatinized starch, or dextrin; or the like.

[0037] The protein is, for example, a grain protein, such as wheat gluten or rye gluten. The synthetic polymer is, for example, polyphosphoric acid, sodium polyacrylate, polyvinylpyrrolidone, or the like. The second shaping agent may be different from the first shaping agent but, like the first shaping agent, may be a polysaccharide, a protein, a synthetic polymer, or the like.

[0038] When the tobacco sheet contains the first shaping agent, the first shaping agent content per 100% by mass of the tobacco sheet preferably ranges from 0.1% to 15% by mass. When the first shaping agent content is 0.1% by mass or more, a raw material mixture can be easily formed into a sheet. When the first shaping agent content is 15% by mass or less, another raw material for ensuring a function required for the tobacco-containing segment of the non-combustion heating-type flavor inhaler can be sufficiently used. The first shaping agent content more preferably ranges from 0.1% to 12% by mass, still more preferably 0.1% to 10% by mass, particularly preferably 0.1% to 7% by mass.

[0039] When the tobacco sheet contains the second shaping agent, the second shaping agent content per 100% by mass of the tobacco sheet preferably ranges from 0.1% to 15% by mass. When the second shaping agent content is 0.1% by mass or more, a raw material mixture can be easily formed into a sheet. When the second shaping agent content is 15% by mass or less, another raw material for ensuring a function required for the tobacco-containing segment of the non-combustion heating-type flavor inhaler can be sufficiently used. The second shaping agent content more preferably ranges from 0.1% to 12% by mass, still more preferably 0.1% to 10% by mass, particularly preferably 0.1% to 7% by mass.

[0040] When the first shaping agent and the second shaping agent are of the same type but different in form, for example, the first shaping agent may be a powder, and the second shaping agent may be a solution or a slurry. For example, in a method for manufacturing a tobacco sheet described later, a shaping agent in the form of powder may be directly mixed as the first shaping agent, and a shaping agent dispersed or swollen in a solvent, such as water, may be mixed as the second shaping agent. Such a method also has the same effects as the use of two shaping agents of different types.

(Reinforcing Agent)

[0041] The tobacco sheet according to the present embodiment can further contain a reinforcing agent from the perspective of further improving physical properties. The reinforcing agent is, for example, a fibrous material, such as fibrous pulp or fibrous synthetic cellulose, a liquid material with a surface coating function of forming a film when dried, such as aqueous pectin suspension, or the like. These may be used alone or in combination.

[0042] When the tobacco sheet contains a reinforcing agent, the reinforcing agent content per 100% by mass of the tobacco sheet preferably ranges from 4% to 40% by mass. In this range, another raw material for ensuring a function required for the tobacco-containing segment of the non-combustion heating-type flavor inhaler can be sufficiently used. The reinforcing agent content more preferably ranges from 4.5% to 35% by mass, still more preferably 5% to 30% by mass.

(Humectant)

[0043] The tobacco sheet according to the present embodiment can further contain a humectant from the perspective of quality preservation. The humectant is, for example, a sugar alcohol, such as sorbitol, erythritol, xylitol, maltitol, lactitol, mannitol, or reduced maltose syrup, or the like. These may be used alone or in combination.

[0044] When the tobacco sheet contains a humectant, the humectant content per 100% by mass of the tobacco sheet preferably ranges from 1% to 15% by mass. In this range, another raw material for ensuring a function required for the tobacco-containing segment of the non-combustion heating-type flavor inhaler can be sufficiently used. The humectant content more preferably ranges from 2% to 12% by mass, still more preferably 3% to 10% by mass.

(Other Components)

[0045] The tobacco sheet according to the present embodiment can contain, in addition to the tobacco raw material, the aerosol generator, the shaping agents (the first and second shaping agents), the reinforcing agent, and the humectant, if necessary, a flavoring and seasoning agent, such as a flavoring agent or a taste agent, a colorant, a wetting agent, a preservative, a diluent, such as an inorganic substance, and/or the like.

(Bulkiness)

[0046] The tobacco sheet according to the present embodiment preferably has a bulkiness of 190 cc/100 g or more. When the bulkiness is 190 cc/100 g or more, the total heat capacity of the tobacco-containing segment of the non-combustion heating-type flavor inhaler can be sufficiently reduced, and a tobacco sheet filled in the tobacco-containing segment can contribute more to aerosol generation. The bulkiness is more preferably 210 cc/100 g or more, still more preferably 230 cc/100 g or more. The upper limit of the bulkiness is, for example, but not limited to, 800 cc/100 g or less. The bulkiness is a value measured with DD-60A (trade name, manufactured by Borgwaldt KC Inc.) after the tobacco sheet is cut into a size of 0.8 mm×20 mm and is allowed to stand in a conditioned room at 22° C. and 60% for 48 hours. The measurement is performed by putting 15 g of the shredded tobacco sheet into a cylindrical vessel with an inside diameter of 60 mm and determining the volume of the tobacco sheets compressed at a load of 3 kg for 30 seconds.

[Method for Manufacturing Tobacco Sheet]

[0047] The method for manufacturing tobacco sheet according to the present embodiment can include, for example, a step of preparing a mixture containing a tobacco raw material, an aerosol generator, a first shaping agent, and a second shaping agent, a step of rolling the mixture to form a rolled product, and a step of pressing a rotary roll blade against the rolled product to cut the rolled product into a strip while imparting a wavy shape to the strip. The process of imparting a wavy shape is also referred to as a rippling process. For example, the tobacco sheet according to the present embodiment can be produced by the following method.

[0048] (1) A step of mixing water, a tobacco raw material, an aerosol generator, first and second shaping agents, and a reinforcing agent to prepare a mixture.

[0049] (2) A step of putting the mixture into a plurality of rolling rollers and rolling the mixture to produce a rolled product.

[0050] (3) A step of pressing a rotary roll blade against the rolled product to cut the rolled product into a strip while imparting a wavy shape to the strip.

[0051] When a sheet cut into a strip by a rotary roll blade is separated from the roll, a resistance applied to the sheet imparts a wavy shape and a serrated shape to the sheet as illustrated in FIG. **1**. When a rolled product is not cut with a rotary roll blade, for example, when a rolled product on a rolling roller is peeled off using a doctor knife, a resistance applied by separating the rolled product from the roll can impart a wavy shape and a serrated shape in the same manner. Furthermore, when a tobacco sheet is produced by the method, depending on the purpose, the surface of a rolling roller may be heated or cooled, or the number of revolutions of the rolling roller may be adjusted. Furthermore, a tobacco sheet with a desired basis weight can be formed by adjusting the distance between rolling rollers.

[Non-Combustion Heating-Type Flavor Inhaler]

[0052] A non-combustion heating-type flavor inhaler according to the present embodiment includes a tobacco-containing segment containing the tobacco sheet according to the present embodiment or the like. Since the non-combustion heating-type flavor inhaler according to the present embodiment includes the tobacco-containing segment filled with the tobacco sheet with a high bulkiness according to the present embodiment or the like, the total heat capacity of the tobacco-containing segment can be sufficiently reduced, and the tobacco sheet filled in the tobacco-containing segment can contribute more to aerosol generation.

[0053] FIG. **2** illustrates an example of the non-combustion heating-type flavor inhaler according to the present embodiment. A non-combustion heating-type flavor inhaler **4** illustrated in FIG. **2** includes a tobacco-containing segment **5** filled with the tobacco sheet according to the present embodiment or the like, a tubular cooling segment **6** with a hole **11** on the periphery, a center hole segment **7**, and a filter segment **8**. The non-combustion heating-type flavor inhaler according to the present embodiment may have another segment, in addition to the tobacco-containing segment, the cooling segment, the center hole segment, and the filter segment.

[0054] The non-combustion heating-type flavor inhaler according to the present embodiment may have any axial length and preferably has an axial length of 40 mm or more and 90 mm or less, more preferably 50 mm or more and 75 mm or less, still more preferably 50 mm or more and 60 mm or less. The non-combustion heating-type flavor inhaler preferably has a circumferential length of 16 mm or more and 25 mm or less, more preferably 20 mm or more and 24

mm or less, still more preferably 21 mm or more and 23 mm or less. For example, the tobacco-containing segment has a length of 20 mm, the cooling segment has a length of 20 mm, the center hole segment has a length of 8 mm, and the filter segment has a length of 7 mm. The length of the filter segment can be selected in the range of 4 mm or more and 10 mm or less. The airflow resistance of the filter segment is selected in the range of 15 mmH_2O/seg or more and 60 mmH_2O/seg or less per segment. The length of each segment can be appropriately changed according to the manufacturability, quality requirements, and the like. Only the filter segment on the downstream side of the cooling segment without the center hole segment can also function as a non-combustion heating-type flavor inhaler.

(Tobacco-Containing Segment)

[0055] The tobacco-containing segment **5** is filled with the tobacco sheet according to the present embodiment in a wrapping paper (hereinafter also referred to as a wrapper). The wrapping paper may be filled with the tobacco sheet by any method, for example, by wrapping the tobacco sheet with the wrapper or by filling a tubular wrapper with the tobacco sheet. When the shape of the tobacco sheet has a longitudinal direction like a rectangular shape, the tobacco sheet may be packed such that the longitudinal direction is an unspecified direction in the wrapper or may be packed so as to be aligned in the axial direction of the tobacco-containing segment **5** or in a direction perpendicular to the axial direction.

(Cooling Segment)

[0056] As illustrated in FIG. **2**, the cooling segment **6** may be constituted by a tubular member **10**. The tubular member **10** may be, for example, a paper tube prepared by processing a thick paper into a cylindrical shape.

[0057] The tubular member **10** and a mouthpiece lining paper **15** described later have the hole **11** passing therethrough. The hole **11** allows the outside air to be introduced into the cooling segment **6** during inhalation. This brings a vaporized aerosol component generated by heating the tobacco-containing segment **5** into contact with the outside air, lowers the temperature of the vaporized aerosol component, liquefies the vaporized aerosol component, and forms an aerosol. The hole **11** may have any diameter (full length), for example, a diameter in the range of 0.5 mm or more and 1.5 mm or less. The number of holes **11** may be, but is not limited to, one or two or more. For example, a plurality of holes **11** may be provided on the periphery of the cooling segment **6**.

[0058] The amount of outside air introduced through the hole **11** is preferably 85% by volume or less, more preferably 80% by volume or less, of the volume of the whole gas inhaled by the user. When the amount of outside air is 85% by volume or less, it is possible to sufficiently reduce the decrease in flavor due to dilution with the outside air. This is also referred to as a ventilation ratio. The lower limit of the ventilation ratio is preferably 55% by volume or more, more preferably 60% by volume or more, in terms of cooling performance.

[0059] The cooling segment may be a segment including a sheet of an appropriate constituent material that is wrinkled, pleated, gathered, or folded. A cross-sectional profile of such an element may have randomly oriented channels. The cooling segment may also include a bundle of longitudinally extending tubes. Such a cooling segment may be formed, for example, by wrapping a pleated, gathered, or folded sheet material with a wrapping paper.

[0060] The cooling segment can have an axial length of, for example, 7 mm or more and 28 mm or less, for example, 18 mm. Furthermore, the cooling segment can be substantially circular in its axial cross-sectional shape and can have a diameter of, for example, 5 mm or more and 10 mm or less, for example, approximately 7 mm.

(Center Hole Segment)

[0061] The center hole segment is composed of a fill layer with one or more hollow portions and an inner plug wrapper (inner wrapping paper) covering the fill layer. For example, as illustrated in FIG. **2**, the center hole segment **7** is composed of a second fill layer **12** with a hollow portion and a second inner plug wrapper **13** covering the second fill layer **12**. The center hole segment **7** has a function of increasing the strength of a mouthpiece segment **9**. The second fill layer **12** may be, for example, a rod with an inside diameter of φ1.0 mm or more and φ5.0 mm or less in which cellulose acetate fibers are densely packed and a plasticizer containing triacetin is added in an amount of 6% by mass or more and 20% by mass or less of the mass of cellulose acetate and is hardened. The fibers in the second fill layer **12** have a high packing density, and air or an aerosol flows only through the hollow portion during inhalation and rarely flows through the second fill layer **12**. The second fill layer **12** inside the center hole segment **7** is a fiber fill layer, and the touch from the outside during use rarely causes discomfort to the user. The center hole segment **7** may have no second inner plug wrapper **13** and may maintain its shape by thermoforming.

(Filter Segment)

[0062] The filter segment **8** may have any structure and may be composed of one or more fill layers. The outer side of the fill layer(s) may be wrapped with one or more wrapping papers. The airflow resistance per segment of the filter segment **8** can be appropriately changed depending on the amount, material, and the like of filler in the filter segment **8**. For example, when the filler is cellulose acetate fibers, increasing the amount of cellulose acetate fibers in the filter segment **8** can increase the airflow resistance. When the filler is cellulose acetate fibers, the packing density of the cellulose acetate fibers may range from 0.13 to 0.18 g/cm^3. The airflow resistance is a value measured with an airflow resistance measuring instrument (trade name: SODIMAX, manufactured by SODIM).

[0063] The filter segment **8** may have any circumferential length, which preferably ranges from 16 to 25 mm, more preferably 20 to 24 mm, still more preferably 21 to 23 mm. The axial length of the filter segment **8** can be selected from 4 to 10 mm and is selected to have an airflow resistance in the range of 15 to 60 mmH_2O/seg. The filter segment **8** preferably has an axial length in the range of 5 to 9 mm, more preferably 6 to 8 mm. The filter segment **8** may have any cross-sectional shape, for example, a circular shape, an elliptical shape, a polygonal shape, or the like. A breakable capsule containing a flavoring agent, flavoring agent beads, or a flavoring agent may be added directly to the filter segment **8**.

[0064] As illustrated in FIG. **2**, the center hole segment **7** and the filter segment **8** can be connected using an outer plug wrapper (outer wrapping paper) **14**. The outer plug wrapper **14** may be, for example, cylindrical paper. The tobacco-containing segment **5**, the cooling segment **6**, and the connected center hole segment **7** and filter segment **8** can be connected using the mouthpiece lining paper **15**. These connections can be made, for example, by applying an adhesive agent, such as a vinyl acetate adhesive agent, to the inner surface of the mouthpiece lining paper **15**, inserting the three segments therein, and wrapping the three segments. These segments may be connected multiple times with a plurality of lining papers.

[Non-Combustion Heating-Type Flavor Inhaling System]

[0065] A non-combustion heating-type flavor inhaling system according to the present embodiment includes the non-combustion heating-type flavor inhaler according to the present embodiment and a heating device for heating the tobacco-containing segment of the non-combustion heating-type flavor inhaler. The non-combustion heating-type flavor inhaling system according to the present embodiment may have another constituent, in addition to the non-combustion heating-type flavor inhaler according to the present embodiment and the heating device.

[0066] FIG. **3** illustrates an example of the non-combustion heating-type flavor inhaling system according to the present embodiment. The non-combustion heating-type flavor inhaling system illustrated in FIG. **3** includes the non-combustion heating-type flavor inhaler **4** according to the present embodiment and a heating device **16** for heating the tobacco-containing segment of the non-combustion heating-type flavor inhaler **4** from the outside.

[0067] FIG. **3**(*a*) illustrates a state before the non-combustion heating-type flavor inhaler **4** is inserted into the heating device **16**, and FIG. **3**(*b*) illustrates a state in which the non-combustion heating-type flavor inhaler **4** is inserted into the heating device **16** and is heated. The heating device **16** illustrated in FIG. **3** includes a body **17**, a heater **18**, a metal tube **19**, a battery unit **20**, and a control unit **21**. The body **17** has a tubular recess **22**. The heater **18** and the metal tube **19** are arranged on the inner side surface of the recess **22** at a position corresponding to the tobacco-containing segment of the non-combustion heating-type flavor inhaler **4** inserted into the recess **22**. The heater **18** may be an electrical resistance heater and is heated by an electric power supplied from the battery unit **20** according to an instruction from the control unit **21** for temperature control. Heat generated by the heater **18** is transferred to the tobacco-containing segment of the non-combustion heating-type flavor inhaler **4** through the metal tube **19** with high thermal conductivity.

[0068] Although there is a space between the outer circumference of the non-combustion heating-type flavor inhaler **4** and the inner circumference of the metal tube **19** in schematically illustrated FIG. **3**(*b*), it is actually desirable that for efficient heat transfer there be no space between the outer circumference of the non-combustion heating-type flavor inhaler **4** and the inner circumference of the metal tube **19**. The heating device **16** heats the tobacco-containing segment of the non-combustion heating-type flavor inhaler **4** from the outside but may heat it from the inside.

[0069] The heating temperature of the heating device is preferably, but is not limited to, 400° C. or less, more preferably 150° C. or more and 400° C. or less, still more preferably 200° C. or more and 350° C. or less. The heating temperature refers to the temperature of the heater of the heating device.

[0070] Furthermore, the tobacco sheet is required to have high processability. A sheet produced by a paper-making method is composed of a fibrous tobacco leaf residue and therefore has high strength, but has insufficient surface smoothness. In a sheet produced by a casting method, a wet sheet in a water-rich state is dried, and steam generation during drying or the like produces bubbles on the surface. Furthermore, the smoothness is not at a sufficient level partly because an end portion of the wet sheet has a low density during water evaporation and shrinkage of the wet sheet. Furthermore, when a fibrous material is blended, the material is entangled and forms a lump, which also impairs the sheet surface smoothness. A tobacco sheet is typically subjected to processing, such as shaping and cutting, to provide a smoking article. In this processing, a tobacco sheet with insufficient surface smoothness may cause a failure, such as a fracture, of the sheet when the sheet comes into contact with a processing apparatus. Thus, a tobacco sheet with high processability in addition to a high bulkiness is described below as a first embodiment.

[0071] Furthermore, during or after use of a known tobacco sheet, a fine powder, so-called fallen shreds, is formed and causes inconvenience in handling, such as adhesion to clothes. Thus, the fallen shreds can be reduced to improve handleability. Thus, a tobacco sheet with fewer fallen shreds in addition to a high bulkiness is described below as a second embodiment.

First Embodiment

[0072] The tobacco sheet according to the present embodiment includes at least a tobacco material and a binder.

(1) Binder

[0073] The binder is a type of the shaping agent described above and is an adhesive agent for binding tobacco materials to each other or binding a tobacco material to another component. In the present embodiment, a known binder can be used. Such a binder is, for example, a polysaccharide, such as guar gum or xanthan gum, or a cellulose derivative, such as carboxymethyl cellulose (CMC), a carboxymethyl cellulose sodium salt (CMC-Na), or hydroxypropyl cellulose (HPC). The binder content based on dry mass (mass excluding water mixed therein, the same applies hereinafter) preferably has an upper limit of 6% by mass or less and preferably has a lower limit of 1% by mass or more, more preferably 3% by mass or more, based on the dry mass of the tobacco sheet. At an amount of binder higher than the upper limit or lower than the lower limit, the effects described above may not be sufficiently exhibited.

[0074] A binder used in the present embodiment may be a polysaccharide, a protein, or a synthetic polymer. Specific examples of these are described below. In the present embodiment, these binders may be used in combination.

1) Polysaccharide

1-1) Cellulose Derivative

[Cellulose Ether]

[0075] Methyl cellulose, ethyl cellulose, hydroxyethyl cellulose, hydroxymethylethyl cellulose, hydroxypropyl cellu-

lose, hydroxypropylmethyl cellulose, benzyl cellulose, trityl cellulose, cyanoethyl cellulose, carboxymethyl cellulose, carboxyethyl cellulose, or aminoethyl cellulose

[Cellulose Ester]

[0076] Organic acid ester: cellulose acetate, cellulose formate, cellulose propionate, cellulose butyrate, cellulose benzoate, cellulose phthalate, or tosyl cellulose

[0077] Mineral acid ester: cellulose nitrate, cellulose sulfate, cellulose phosphate, or a cellulose xanthate salt

1-2) Naturally Occurring Polysaccharide

[Plant-Derived]

[0078] Guar gum, tara gum, locust bean gum, tamarind seed gum, pectin, gum arabic, gum tragacanth, karaya gum, ghatti gum, arabinogalactan, flaxseed gum, cassia gum, psyllium seed gum, or *Artemisia* seed gum

[Algae-Derived]

[0079] Carrageenan, agar, alginic acid, propylene glycol alginate ester, furcellaran, or a Colpomenia sinuosa extract

[Microorganism-Derived]

[0080] Xanthan gum, gellan gum, curdlan, pullulan, *Agrobacterium* succinoglycan, welan gum, Macrophomopsis gum, or rhamsan gum

[Crustacea-Derived]

[0081] Chitin, chitosan, or glucosamine

[Starch]

[0082] Starch, sodium starch glycolate, pregelatinized starch, or dextrin

2) Protein

[0083] Wheat gluten or rye gluten

3) Synthetic Polymer

[0084] Polyphosphoric acid, sodium polyacrylate, or polyvinylpyrrolidone

(2) Tobacco Material

[0085] A tobacco material used in the present embodiment may be the tobacco raw material described above. In the present embodiment, more specifically, shredded dried tobacco leaves, ground leaf tobacco, or the like can be used. The ground leaf tobacco is particles produced by grinding leaf tobacco. The particle diameter D90 of the ground leaf tobacco is preferably 200 μm or more as described above and can preferably has an upper limit of 1000 μm or less, more preferably 50 to 500 μm. The average particle size D50 thereof can preferably range from 20 to 1000 μm, more preferably 50 to 500 μm. The grinding can be performed with a known grinder and may be dry grinding or wet grinding. Thus, the ground leaf tobacco is also referred to as leaf tobacco particles. In the present embodiment, the particle size is determined by a laser diffraction-scattering method and is, more specifically, measured with a laser diffraction particle size distribution measuring apparatus (for example, LA-950 manufactured by Horiba, Ltd.). The type of tobacco may be, but is not limited to, flue-cured varieties, burley varieties, oriental varieties, native varieties, other varieties belonging to *Nicotiana tabacum* varieties or *Nicotiana rustica* varieties, or the like. The amount of the tobacco material in the tobacco sheet is preferably, but not limited to, in the range of 50% to 95% by mass, more preferably 60% to 90% by mass, based on dry mass.

(3) Aerosol Generator

[0086] Also in the present embodiment, a known aerosol generator can be used, and examples thereof include polyhydric alcohols, such as glycerin and propylene glycol (PG), and those with a boiling point of more than 100° C., such as triethyl citrate (TEC) and triacetin. In the present embodiment, the amount of the aerosol generator in the tobacco sheet preferably ranges from 5% to 40% by mass, more preferably 10% to 20% by mass, based on dry mass (mass excluding water mixed therein, the same applies hereinafter). When the amount of the aerosol generator is higher than the upper limit, it may be difficult to produce a tobacco sheet. When the amount of the aerosol generator is lower than the lower limit, smoke sensitivity may decrease.

(4) Emulsifier

[0087] In the present embodiment, the tobacco sheet may contain an emulsifier. The emulsifier increases the affinity between the aerosol generator, which is lipophilic, and the tobacco material, which is hydrophilic. Thus, the addition of the emulsifier is effective particularly when a lipophilic aerosol generator is used. The emulsifier can be a known emulsifier and is, for example, an emulsifier with an HLB value in the range of 8 to 18. The amount of the emulsifier is preferably, but not limited to, in the range of 0.1 to 3 parts by mass, more preferably 1 to 2 parts by mass, based on dry mass with respect to 100 parts by mass of the tobacco sheet.

(6) Flavoring Agent

[0088] In the present embodiment, the tobacco sheet may contain a flavoring agent. The flavoring agent is a substance that provides an aroma or flavor. The flavoring agent may be a natural flavoring agent or a synthetic flavoring agent. The flavoring agent may be one type of flavoring agent or a mixture of multiple types of flavoring agents. The flavoring agent may be any flavoring agent commonly used in smoking articles, and specific examples thereof are described below. The flavoring agent can be contained in a sheet for a smoking article in such an amount that the smoking article can provide a favorable aroma or flavor. For example, the amount of the flavoring agent in the tobacco sheet preferably ranges from 1% to 30% by mass, more preferably 2% to 20% by mass.

[0089] The flavoring agent may be of any type and, from the perspective of imparting flavor sense, may be acetoanisole, acetophenone, acetylpyrazine, 2-acetylthiazole, an alfalfa extract, amyl alcohol, amyl butyrate, trans-anethole, star anise oil, apple juice, Peru balsam oil, beeswax absolute, benzaldehyde, benzoin resinoid, benzyl alcohol, benzyl benzoate, benzyl phenylacetate, benzyl propionate, 2,3-butanedione, 2-butanol, butyl butyrate, butyric acid, caramel, cardamom oil, carob absolute, β-carotene, carrot juice, L-carvone, β-caryophyllene, cassia bark oil, cedar wood oil, celery seed oil, chamomile oil, cinnamaldehyde, cinnamic acid, cinnamyl alcohol, cinnamyl cinnamate, citronella oil,

DL-citronellol, a clary sage extract, cocoa, coffee, cognac oil, coriander oil, cumin aldehyde, davana oil, δ-decalactone, γ-decalactone, decanoic acid, dill herb oil, 3,4-dimethyl-1,2-cyclopentanedione, 4,5-dimethyl-3-hydroxy-2,5-dihydrofuran-2-one, 3,7-dimethyl-6-octenoic acid, 2,3-dimethylpyrazine, 2,5-dimethylpyrazine, 2,6-dimethylpyrazine, ethyl 2-methylbutyrate, ethyl acetate, ethyl butyrate, ethyl hexanoate, ethyl isovalerate, ethyl lactate, ethyl laurate, ethyl levulinate, ethyl maltol, ethyl octanoate, ethyl oleate, ethyl palmitate, ethyl phenylacetate, ethyl propionate, ethyl stearate, ethyl valerate, ethylvanillin, ethylvanillin glucoside, 2-ethyl-3,(5 or 6)-dimethylpyrazine, 5-ethyl-3-hydroxy-4-methyl-2(5H)-furanone, 2-ethyl-3-methylpyrazine, eucalyptol, fenugreek absolute, genet absolute, gentian root infusion, geraniol, geranyl acetate, grape juice, guaiacol, a guava extract, γ-heptalactone, γ-hexalactone, hexanoic acid, cis-3-hexen-1-ol, hexyl acetate, hexyl alcohol, hexyl phenylacetate, honey, 4-hydroxy-3-pentenoic acid lactone, 4-hydroxy-4-(3-hydroxy-1-butenyl)-3,5,5-trimethyl-2-cyclohexen-1-one, 4-(p-hydroxyphenyl)-2-butanone, sodium **4**-hydroxyundecanoate, immortelle absolute, β-ionone, isoamyl acetate, isoamyl butyrate, isoamyl phenylacetate, isobutyl acetate, isobutyl phenylacetate, jasmine absolute, kola nut tincture, labdanum oil, lemon terpeneless oil, a licorice extract, linalool, linalyl acetate, lovage root oil, maltol, maple syrup, menthol, menthone, L-menthyl acetate, p-methoxybenzaldehyde, methyl-2-pyrrolylketone, methyl anthranilate, methyl phenyl acetate, methyl salicylate, 4'-methylacetophenone, methylcyclopentenolone, 3-methylvaleric acid, mimosa absolute, molasses, myristic acid, nerol, nerolidol, γ-nonalactone, nutmeg oil, δ-octalactone, octanal, octanoic acid, orange flower oil, orange oil, orris root oil, palmitic acid, o-pentadecalactone, peppermint oil, petitgrain Paraguay oil, phenethyl alcohol, phenethyl phenylacetate, phenylacetic acid, piperonal, a plum extract, propenyl guaethol, propyl acetate, 3-propylidenephthalide, prune fruit juice, pyruvic acid, a raisin extract, rose oil, rum, sage oil, sandalwood oil, spearmint oil, styrax absolute, marigold oil, tea distillate, α-terpineol, terpinyl acetate, 5,6,7,8-tetrahydroquinoxaline, 1,5,5,9-tetramethyl-13-oxacyclo(8.3.0.0(4.9))tridecane, 2,3,5,6-tetramethylpyrazine, thyme oil, a tomato extract, 2-tridecanone, triethyl citrate, 4-(2,6,6-trimethyl-1-cyclohexenyl) 2-buten-4-one, 2,6,6-trimethyl-2-cyclohexene-1,4-dione, 4-(2,6,6-trimethyl-1,3-cyclohexadienyl)2-buten-4-one, 2,3,5-trimethylpyrazine, γ-undecalactone, γ-valerolactone, a vanilla extract, vanillin, veratraldehyde, violet leaf absolute, N-ethyl-p-menthane-3-carboamide (WS-3), ethyl-2-(p-menthane-3-carboxamide)acetate (WS-5), sugar (sucrose, fructose), a cocoa powder, a carob powder, a coriander powder, a licorice powder, an orange peel powder, a rose hip powder, a chamomile flower powder, a lemon verbena powder, a peppermint powder, a leaf powder, a spearmint powder, a black tea powder, a natural plant flavoring agent (for example, jasmine oil, lemon oil, vetiver oil, lovage oil), an ester (for example, menthyl acetate, isoamyl propionate, or the like), or an alcohol (for example, phenylethyl alcohol, cis-6-nonene-1-ol, or the like). These flavoring agents may be used alone or in combination.

(7) Characteristics and Form of Tobacco Sheet

1) Arithmetic Mean Surface Roughness Sa

[0090] In the tobacco sheet according to the present embodiment, when a surface between two peaks that determine the period of a wave in a cross-section is referred to as an arcuate curved surface, at least one of two arcuate curved surfaces present on the front and back surfaces of the sheet preferably has an Sa in the range of 5 to 30 μm. FIG. **1**(**2**) illustrates the tobacco sheet according to the present embodiment. In the figure, the inner surface (the surface on the lower side of the drawing) and the outer surface (the surface on the upper side of the drawing) of the tobacco sheet in the region denoted by "a" are arcuate curved surfaces. In the present embodiment, since there are a plurality of regions denoted by "a", Sa of each region denoted by "a" is measured and is averaged as Sa of the arcuate curved surface of the sheet. Although the wavy shape of the cross-section is arcuate in FIG. **1**(**2**), even when the wavy shape of the cross-section is triangular, a surface between two peaks that determine the period of a wave is also referred to as an arcuate curved surface. Sa is a measure of the surface roughness. The tobacco sheet according to the present embodiment with an arcuate curved surface having Sa in the above range has high processability and fewer shreds falling from the surface thereof. The reason for this is not particularly limited and is surmised as described below. The wavy shape is formed by processing a sheet with an arithmetic mean surface roughness Sa in the above range. Since the sheet is smooth, stress is less likely to be concentrated on the sheet surface due to deformation during processing, and the occurrence of a crack (a fissure or breakage) due to the processing can be reduced. Furthermore, a sheet with an arithmetic mean surface roughness Sa in the above range comes into contact with a processing machine during the processing, but the sheet is smooth and is not severely damaged due to the contact, and the occurrence of a scraping, such as a powder, can be reduced. From this perspective, Sa more preferably ranges from 10 to 25 μm, still more preferably 10 to 20 μm. In the tobacco sheet according to the present embodiment, the two arcuate curved surfaces preferably have Sa in the above range. The Sa is measured by a known method, preferably a method described below.

[0091] Measurement is performed with a microscope (for example, VK-X100 manufactured by KEYENCE) by the following procedure.

[0092] 1) Set the focal position of the lowest portion of an object to be measured on the sheet

[0093] 2) Set the focal position of the highest portion of the object to be measured on the sheet

[0094] 3) Divide the section obtained in 1) and 2) and take an image while gradually shifting the focus

[0095] 4) Measure the height from the difference between the focal position of each portion and the focal position of the lowest portion

[0096] 5) Calculate (automatically calculate using measuring machine software) roughness from height data at each position and calculate arithmetic surface roughness Sa

2) Thickness

[0097] The thickness of the tobacco sheet is preferably, but not limited to, in the range of 20 to 2000 μm, more preferably 100 to 1500 μm, still more preferably 100 to 1000 μm, in one embodiment.

3) Mechanical Characteristics

[0098] The tobacco sheet according to the present embodiment preferably has a tensile elongation of 2.0% or more,

more preferably 3.0% or more, still more preferably 5.0% or more. The upper limit of the tensile elongation is typically, but not limited to, approximately 15% or less. The tobacco sheet preferably has a tensile stress of 2.0 N/mm or more, more preferably 2.5 N/mm or more, still more preferably 3.0 N/mm or more.

4) Handleability

[0099] The smoothness of an arcuate curved surface of the tobacco sheet according to the present embodiment has an influence on the handleability of the product. For example, the sheet may be damaged when a smoking article including a tobacco sheet having an arcuate curved surface with low smoothness comes into contact with a processing apparatus. Furthermore, during or after use, a fine powder, so-called fallen shreds, may be formed and may cause inconvenience in handling, such as adhesion to clothes. However, the arcuate curved surface of the tobacco sheet according to the present embodiment has high smoothness and is less likely to have such a failure.

(8) Tobacco Segment

[0100] A tobacco segment for use in a smoking article can be produced from a tobacco sheet. In one embodiment, the tobacco segment includes a tubular wrapper and a tobacco sheet helically packed in the wrapper (see FIG. **4**(A)). In the figure, **200**A denotes a tobacco segment, T denotes a tobacco sheet, and **220** denotes a wrapper, which is typically paper. The tobacco segment is preferably rod-like and may have a length in the range of approximately 15 to 80 mm and a diameter in the range of approximately 5 to 10 mm. Furthermore, the tobacco segment **200**A illustrated in FIG. **4**(A) may be cut to have an aspect ratio (length/diameter) in the range of approximately 0.5 to 1.2 (see FIG. **4**(B)).

[0101] In another embodiment, the tobacco segment **200**A has a tubular wrapper **220** and a tobacco sheet T folded and packed in the wrapper. A ridgeline formed by folding is approximately parallel to the longitudinal direction of the segment (see FIG. **4**(C)). The tobacco segment **200**A is preferably rod-like and may have a length in the range of approximately 15 to 80 mm and a diameter in the range of approximately 5 to 10 mm. In the present embodiment, the tobacco sheet T is preferably subjected to surface wrinkling, such as pleating or crimping, in advance.

[0102] In another embodiment, the tobacco segment **200**A has the tubular wrapper **220** and cut pieces of the tobacco sheet T packed in the wrapper (see FIG. **4**(D)). The tobacco segment **200**A is preferably rod-like and may have a length in the range of approximately 15 to 80 mm and a diameter in the range of approximately 5 to 10 mm. Each cut piece may have any size and, for example, may have a longest side length in the range of approximately 2 to 20 mm and a width in the range of approximately 0.5 to 1.5 mm.

[0103] In another embodiment, the tobacco segment **200**A has the tubular wrapper **220** and shredded strands packed in the wrapper (see FIG. **4**(E)). The shredded strands are packed such that the longitudinal direction thereof is approximately parallel to the longitudinal direction of the wrapper **220**. Each shredded strand may have a width in the range of approximately 0.5 to 1.5 mm.

[0104] In another embodiment, the tobacco segment **200**A has the tubular wrapper **220** and a shredded tobacco filler randomly packed in the wrapper. Shredded tobacco is cut shreds and is different from shredded strands.

[Manufacturing Method]

[0105] A tobacco sheet before being corrugated in the present embodiment can be produced by any method, preferably a method including the following steps.

[0106] Step 1 of kneading at least a tobacco material, a binder, and a medium to prepare a mixture.

[0107] Step 2 of pressure-extending the mixture or extruding the mixture through a die to prepare a wet sheet.

[0108] Step 3 of drying the wet sheet.

[0109] A sheet formed by applying pressure in this manner is referred to as a "press-formed sheet", and the "press-formed sheet" includes a "laminated sheet" and an "extruded sheet", as described later. The laminated sheet is a sheet produced by pressure-extending the mixture one or more times to a target thickness using a roller and then drying the mixture to a target water content. The extruded sheet is a sheet produced by extruding the mixture through a T-die or the like to a target thickness and then drying the mixture to a target water content. In a press-formed sheet, pressure extension and extrusion may be combined. For example, the mixture may be extruded and then further pressure-extended to form a sheet.

(1) Step 1

[0110] In this step, the tobacco material, the binder, and the medium are kneaded. If necessary, an aerosol-generating material, an emulsifier, or a flavoring agent may also be added. The amount of each component is adjusted to achieve the amount described above.

[0111] The medium is preferably, for example, composed mainly of water or a water-soluble organic solvent with a boiling point of less than 100° C., such as ethanol, and is more preferably water or ethanol.

[0112] This step can be performed by kneading the components and is preferably performed through 1) grinding of a raw material (for example, a single leaf), 2) preparation of a wet powder, and 3) kneading.

1) Grinding

[0113] Preferably, a raw material is coarsely ground and is then finely ground using a grinder (for example, ACM-5 manufactured by Hosokawa Micron Corporation). The particle diameter D90 after the fine grinding preferably ranges from 20 to 1000 μm. The particle size is measured with a laser diffraction particle size analyzer, such as Mastersizer (manufactured by malvern).

2) Preparation of Wet Powder

[0114] A binder and an optional additive agent, such as a flavoring agent or a lipid, are added to and mixed with the ground tobacco raw material (for example, leaf tobacco particles). This mixing is preferably dry blending, and a mixer is preferably used as a mixing machine. A medium, such as water, and an optional aerosol-generating material, such as glycerin, are then added to the dry blend and are mixed using a mixer to prepare a wet powder (a powder in a wet state). The amount of the medium in the wet powder can range from 20% to 80% by mass, preferably 20% to 40% by mass, and the wet powder is appropriately adjusted in the step 2. For example, the amount of the medium can range

from 20% to 50% by mass in the case of pressure extension and 20% to 80% by mass in the case of extrusion in the step 2. The wet powder preferably has a solid concentration in the range of 50% to 90% by mass.

3) Kneading

[0115] The wet powder is kneaded with a kneader (for example, DG-1 manufactured by Dalton Corporation). The kneading is preferably performed until the medium is wholly dispersed. For example, the kneading is preferably performed until the color of the mixture is visually uniform.

(2) Step 2

[0116] In this step, the mixture (wet powder) is pressure-extended or extruded through a die to prepare a wet sheet. For example, the mixture sandwiched between two substrate films can be passed between a pair of rollers to a predetermined thickness (more than 100 μm) using a calender (for example, manufactured by Yuri Roll Machine Co., Ltd.) and can be pressure-extended to form a laminate of a wet sheet sandwiched between the two substrate films. The substrate film is preferably a non-adhesive film, such as a fluorinated polymer film. The pressure extension using a roller can be performed multiple times. Alternatively, the mixture (wet powder) may be extruded through a die (preferably a T-die) with a predetermined gap to form a wet sheet on a substrate. The substrate may be a known substrate, such as a glass sheet, a metal sheet, or a plastic sheet. A known extruder can be used for the extrusion.

(3) Step 3

[0117] In this step, the wet sheet is dried. For example, the laminate can be subjected to this step by the following procedure. 1) One of the substrate films is peeled off. 2) The laminate is dried with a forced-air dryer. The drying temperature may be room temperature and preferably ranges from 50° C. to 100° C., and the drying time can range from 1 to 2 minutes. 3) The remaining substrate film is then peeled off, and drying is further performed under the conditions described above to produce a tobacco sheet. Such drying can prevent the tobacco sheet from adhering to another substrate. The tobacco sheet thus produced is also referred to as a "laminated sheet". The laminated sheet is preferred because it has a smooth surface and can have fewer fallen shreds when coming into contact with another member. This method is suitable for the production of a sheet of 300 μm or less.

[0118] In extrusion, the wet sheet on the substrate is dried by air drying or heating. The drying conditions are as described above. The tobacco sheet thus produced is also referred to as an "extruded sheet". The extruded sheet is preferred because it has a smooth surface and can have fewer fallen shreds when coming into contact with another member. This method is suitable for the production of a sheet of 200 μm or more.

Second Embodiment

[0119] A tobacco sheet according to the present embodiment contains a tobacco material and a cellulose derivative with a degree of substitution of 0.65 or more as a binder.

(1) Binder

[0120] In the present embodiment, the cellulose derivative with a degree of substitution of 0.65 or more, which is a binder, is used as a shaping agent. The cellulose derivative is a cellulose in which an —OH group of the glucopyranose residue is modified. A cellulose with an —OH group modified to an —OR group (R denotes an organic group) is also referred to as a cellulose ether, and a cellulose with an —OH group modified to an —OX group (X denotes a group derived from an acid) is also referred to as a cellulose ester, and both of them can be used in the present invention.

[0121] The degree of substitution is the number of substituents per glucopyranose residue, that is, the number of modified OH groups. The degree of substitution used in the present invention is preferably 0.65 or more, more preferably 0.7 or more, still more preferably 0.8 or more. The upper limit of the degree of substitution is preferably 3.0 or less, more preferably 2.0 or less, still more preferably 1.6 or less, particularly preferably 1.0 or less.

[0122] The degree of substitution is determined by a known method. For example, the degree of substitution is determined by a nitric acid-methanol method. In the method, 1) approximately 2.0 g of a sample is precisely weighed and is put into a 300-ml stoppered conical flask. 100 ml of nitric acid-methanol (a liquid prepared by adding 100 ml of special grade concentrated nitric acid to 1 g of anhydrous methanol) is added and shaken for approximately 2 hours to convert a terminal acid group from a salt-type to a hydrogen-type (for example, from COONa to COOH). 2) The sample is filtered through a glass filter 1G3, is washed with 200 ml of 80% methanol, and is then dried at 105° C. for 2 hours. 3) Approximately 1 to 1.5 g of the absolutely dried sample is precisely weighed, is put into a 300-ml stoppered conical flask, is wetted with 150 ml of 80% methanol, is mixed with 50 ml of 0.1 N NaOH, and is shaken at room temperature for 2 hours. Excess NaOH is back-titrated with 0.1 N sulfuric acid using phenolphthalein as indicator. 4) The degree of substitution is determined using the following formula:

$$\text{Degree of substitution} = 0.162A/(1 - 0.058A)$$

$$A = 50 \times F' - \text{amount of the sulfuric acid (ml)} \times F/\text{absolute dry sample mass (g)} \times 0.1$$

F:Factor of the sulfuric acid

F:Factor of the NaOH

[0123] The cellulose ether has up to three R groups, and each R may be the same or different. R may be a C1 to C3 linear or branched alkyl group, such as a methyl group, an ethyl group, or a propyl group; a C1 to C3 linear or branched hydroxyalkyl group, such as a hydroxymethyl group, a hydroxyethyl group, or a hydroxypropyl group; a C7 to C20 arylalkyl group, such as a benzyl group or a trityl group; a cyanoalkyl group, such as a cyanoethyl group; a carboxyalkyl group, such as a carboxymethyl group or a carboxyethyl group; or an aminoalkyl group, such as an aminoethyl group. Among these, R is preferably a carboxyalkyl group, more preferably a carboxymethyl group. The degree of substitution in the cellulose ether is also referred to as the degree of etherification.

[0124] The cellulose ester has up to three X groups, and each X may be the same or different. X may be a group derived from a C0 to C4 carboxylic acid, such as formic acid, acetic acid, propionic acid, or butyric acid; a group derived from a C6 to C10 aromatic carboxylic acid, such as benzoic acid or phthalic acid; a group derived from sulfonic acid, such as p-toluenesulfonic acid; a group derived from mineral acid, such as nitric acid, sulfuric acid, or phosphoric acid; or a group derived from xanthic acid. The degree of substitution in the cellulose ester is also referred to as the degree of esterification.

[0125] Due to its high hydrophilicity, the cellulose derivative used as a binder improves the affinity for a tobacco material. This improves the strength of the tobacco sheet and reduces fallen shreds during use.

[0126] Furthermore, the cellulose derivative is soluble in an organic solvent, in particular in ethanol. Thus, as described later, the use of a mixture containing ethanol as a medium in the production of a tobacco sheet can reduce the viscosity of the mixture and is therefore more advantageous than a mixture containing water as a medium in a transport, coating, or other step in the production. Furthermore, since ethanol is more volatile than water, the production time and the energy cost for drying can be reduced in the production method.

[0127] The amount of the cellulose derivative in the tobacco sheet based on dry mass (mass excluding water mixed therein, the same applies hereinafter) is preferably, but not limited to, in the range of 0.1% to 10% by mass, more preferably 1% to 5% by mass, still more preferably 2% to 4% by mass, based on the dry mass of the tobacco sheet. At an amount of binder higher than the upper limit or lower than the lower limit, the effects described above may not be sufficiently exhibited.

[0128] Specific examples of the cellulose derivative are described below.

[0129] Cellulose ethers: methyl cellulose, ethyl cellulose, hydroxyethyl cellulose, hydroxymethylethyl cellulose, hydroxypropyl cellulose, hydroxypropylmethyl cellulose, benzyl cellulose, trityl cellulose, cyanoethyl cellulose, carboxymethyl cellulose, carboxyethyl cellulose, and aminoethyl cellulose

[0130] Cellulose esters: organic acid esters, such as cellulose acetate, cellulose formate, cellulose propionate, cellulose butyrate, cellulose benzoate, cellulose phthalate, and tosyl cellulose; and mineral acid esters, such as cellulose nitrate, cellulose sulfate, cellulose phosphate, and a cellulose xanthate salt

(2) Tobacco Material

[0131] In the present embodiment, the tobacco material described in the first embodiment can be used.

(3) Aerosol Generator

[0132] In the present embodiment, the tobacco sheet may contain the aerosol generator described in the first embodiment.

(4) Emulsifier

[0133] In the present embodiment, the tobacco sheet may contain the emulsifier described in the first embodiment.

(5) Cellulose Other than Tobacco

[0134] In the present embodiment, the tobacco sheet may contain a cellulose other than tobacco. The cellulose other than tobacco is, for example, the cellulose fiber or cellulose powder described above and does not include a cellulose derivative as a binder.

(6) Flavoring Agent

[0135] In the present embodiment, the tobacco sheet may contain the flavoring agent described in the first embodiment.

(7) Characteristics and Form of Tobacco Sheet

1) Thickness

[0136] The thickness w**3** of the tobacco sheet according to the present embodiment is preferably, but not limited to, in the range of 20 to 2000 μm, more preferably 100 to 1500 μm, still more preferably 100 to 1000 μm, in one embodiment.

2) Strength

[0137] The tobacco sheet according to the present embodiment preferably has a tensile stress of 1.7 N/mm or more, more preferably 2 N/mm or more, still more preferably 3 N/mm or more.

3) Arithmetic Mean Surface Roughness Sa

[0138] The arcuate curved surface of the tobacco sheet according to the present embodiment preferably has an arithmetic mean surface roughness Sa of 0.03 mm or less. Sa is a measure of the surface roughness, and the tobacco sheet according to the present embodiment with Sa in the above range has fewer shreds falling from the surface thereof. From this perspective, the upper limit of Sa is more preferably 0.02 mm or less.

(8) Tobacco Segment

[0139] A tobacco segment for use in a smoking article can be produced from a tobacco sheet. The tobacco segment in the present embodiment is as described above in the first embodiment.

[Manufacturing Method]

[0140] A tobacco sheet before being corrugated in the present embodiment can be produced by any method, preferably a method including the following steps.

[0141] Step 1 of preparing a mixture containing at least a tobacco material, the cellulose derivative, and a medium,

[0142] step 2 of spreading the mixture on a substrate to prepare a wet sheet, and

[0143] step 3 of drying the wet sheet.

(1) Step 1

[0144] In this step, a tobacco material, a cellulose derivative as a binder, and a medium are mixed. If necessary, an aerosol-generating material, an emulsifier, or a flavoring agent may also be added. The amount of each component is adjusted to achieve the amount described above. The medium is preferably, for example, composed mainly of water or a water-soluble organic solvent with a boiling point of less than 100° C., such as ethanol, and is more preferably water or ethanol. The mixing method is not particularly

limited, and a known device, such as a mixer or a kneader, can be used. The mixture prepared by the mixing may have any solid concentration and is appropriately adjusted so as to be suitable for the step 2. For example, the upper limit of the solid concentration is preferably 98% by mass or less, 90% by mass or less, or 80% by mass or less, and the lower limit thereof is preferably 10% by mass or more, 20% by mass or more, 30% by mass or more, 40% by mass or more, or 50% by mass or more.

(2) Step 2 In this step, the mixture is spread on a substrate to prepare a wet sheet. The

[0145] substrate may be, but is not limited to, an inorganic material substrate, such as a glass sheet, a metal substrate, such as an aluminum sheet, an organic material substrate, such as a PET film or a fluoropolymer film, a fiber material substrate, such as a non-woven fabric, or the like. The method for spreading the mixture on the substrate may be, but not limited to, a rolling method for pressure extension using a roller, an extrusion method for extrusion through a die, or a casting method for casting, as described later.

(3) Drying Step

[0146] In this step, the wet sheet is dried. The drying can be performed by a known method. For example, the wet sheet can be air-dried at room temperature or dried by heating. The heating temperature can be, for example, but is not limited to, in the range of 60° C. to 150° C. The dried sheet is separated from the substrate to produce a tobacco sheet.

[0147] A preferred embodiment of a method for manufacturing the tobacco sheet according to the present embodiment is described below.

[Rolling Method]

1) Step 1

1-1) Grinding

[0148] A raw material (for example, a single leaf) is coarsely ground. Fine grinding is then performed with a grinder (for example, ACM-5 manufactured by Hosokawa Micron Corporation). The particle diameter (D90) after the fine grinding preferably ranges from 50 to 800 μm. The particle size is measured with a laser diffraction particle size analyzer, such as Mastersizer (manufactured by malvern).

1-2) Preparation of Wet Powder

[0149] A binder, a fibrous material, and an optional additive agent, such as a flavoring agent or a lipid, are added to and mixed with the ground tobacco raw material (for example, tobacco particles). This mixing is preferably dry blending, and a mixer is preferably used as a mixing machine. A medium, such as water, and an optional aerosol-generating material, such as glycerin, are then added to the dry blend and are mixed using a mixer to prepare a wet powder (a powder in a wet state). The amount of the medium in the wet powder can range from 20% to 80% by mass, preferably 20% to 40% by mass, and may range from 20% to 50% by mass for pressure extension in the step 2. The wet powder preferably has a solid concentration in the range of 50% to 90% by mass.

1-3) Kneading

[0150] The wet powder is kneaded with a single-screw or multi-screw kneading machine, for example, a kneader (DG-1 manufactured by Dalton Corporation). The kneading is preferably performed until the medium is wholly dispersed. For example, the kneading is preferably performed until the color of the mixture is visually uniform.

2) Step 2 (Pressure Extension)

[0151] The kneaded mixture sandwiched between two substrate films is passed between a pair of rollers to a predetermined thickness (more than 100 μm) using a calender (for example, manufactured by Yuri Roll Machine Co., Ltd.) and is pressure-extended to form a laminate of a wet sheet sandwiched between the two substrate films. The pressure extension using a roller can be performed multiple times. The substrate film is preferably a non-adhesive film, such as a fluorinated polymer film, more specifically a Teflon (registered trademark) film.

3) Step 3

[0152] One of the substrate films in the laminate is peeled off. The laminate is dried with a forced-air dryer. The drying temperature preferably ranges from 50° C. to 100° C., and the drying time can range from 1 to 2 minutes. The remaining substrate film is then peeled off, and drying is further performed under the conditions described above to produce a tobacco sheet. Such drying can prevent the tobacco sheet from adhering to another substrate.

[0153] The tobacco sheet produced by this method is also referred to as a "laminated sheet". The laminated sheet is preferred because it has a smooth surface and can have fewer fallen shreds when coming into contact with another member. This method is suitable for the production of a sheet of 300 μm or less.

[Extrusion Method]

1) Step 1

[0154] The step 1 in this method is as described above in the rolling method. A wet powder (a powder in a wet state) is prepared. In extrusion in the step 2, the amount of the medium in the wet powder can be selected in the range of 20% to 80% by mass and preferably ranges from 20% to 40% by mass.

2) Step 2

[0155] In this step, the wet powder is extruded through a die with a predetermined gap to form a wet sheet on a substrate. A known extruder can be used for the extrusion.

3) Step 3

[0156] In this step, the wet sheet is dried to produce a tobacco sheet. The drying conditions are as described above in the rolling method. The tobacco sheet produced by this method is also referred to as an "extruded sheet". The extruded sheet is preferred because it has a smooth surface and can have fewer fallen shreds when coming into contact with another member. This method is suitable for the production of a sheet of 200 μm or more.

[0157] A sheet formed by applying pressure in this manner is referred to as a "press-formed sheet", and the "press-

formed sheet" includes a "laminated sheet" and an "extruded sheet". The laminated sheet is a sheet produced by pressure-extending the mixture one or more times to a target thickness using a roller and then drying the mixture to a target water content. The extruded sheet is a sheet produced by extruding the mixture through a T-die or the like to a target thickness and then drying the mixture to a target water content. In a press-formed sheet, pressure extension and extrusion may be combined. For example, the mixture may be extruded and then further pressure-extended to form a sheet.

[Casting Method]

1) Step 1

[0158] The step 1 in this method can be performed by any method. For example, a tobacco raw material with a desired particle size, a cellulose derivative, a medium, and an optional additive agent can be mixed using a mixer or the like to prepare a mixture. The mixture prepared in this step preferably has a solid concentration in the range of approximately 3% to 15% by mass and is therefore also referred to as a slurry.

2) Step 2

[0159] In this step, the slurry is cast on a substrate to form a wet sheet. The casting can be performed as known in the art.

3) Step 3

[0160] In this step, the wet sheet is dried to produce a tobacco sheet. The drying conditions are as described above in the rolling method. The tobacco sheet produced by this method is also referred to as a "cast sheet".

EXAMPLES

[0161] Although specific examples of the present embodiment are described below, the present invention is not limited to these examples.

Example 1

[0162] A tobacco lamina (leaf tobacco) was dry-ground with a Hosokawa Micron ACM machine to produce a tobacco powder. The tobacco powder had a cumulative 90% particle diameter (D90) of 200 μm in a volume-based particle size distribution as measured by a dry laser diffraction method using Mastersizer (trade name, manufactured by Spectris Co., Ltd., Malvern Panalytical).

[0163] The tobacco powder was used as a tobacco raw material to produce a tobacco sheet. More specifically, 70 parts by mass of the tobacco raw material, 12 parts by mass of glycerin as an aerosol generator, 4 parts by mass of powdered carboxymethyl cellulose as a first shaping agent, 1 part by mass of carboxymethyl cellulose swollen with water as a second shaping agent, 5 parts by mass of fibrous pulp as a reinforcing agent, and 8 parts by mass of a cocoa powder as a flavoring agent were mixed and kneaded using an extruder. The kneaded product was formed into a sheet using two pairs of metallic rolls to produce a rolled product. A rotary roll blade for noodle making was pressed against the rolled product to cut the rolled product into a strip while imparting a wavy shape to the strip. The strip was cut into a length of 20 mm and was dried to produce a tobacco sheet with a length of 20 mm and a width of 0.8 mm. A cross-section of the tobacco sheet in the thickness direction had a cross-sectional shape as illustrated in FIG. **1**.

[0164] The bulkiness of the tobacco sheet was measured. More specifically, after the tobacco sheet was allowed to stand in a conditioned room at 22° C. and 60% for 48 hours, the bulkiness was measured with DD-60A (trade name, manufactured by Borgwaldt KC Inc.). The measurement was performed by putting 15 g of a tobacco sheet into a cylindrical vessel with an inside diameter of 60 mm and determining the volume of the tobacco sheet compressed at a load of 3 kg for 30 seconds. Table 1 shows the results. In Table 1, the bulkiness is shown by a rate of increase in bulkiness (%) with respect to the bulkiness of Comparative Example 1 described later.

Comparative Example 1

[0165] A rolled product was produced in the same manner as in Example 1. It was then cut into a strip with a plurality of ring-shaped rotary blades. The strip was cut into a length of 20 mm to produce a tobacco sheet 20 mm in length and 0.8 mm in width having no wavy shape. The bulkiness of the tobacco sheet was measured in the same manner as in Example 1. Table 1 shows the results.

TABLE 1

	Rate of increase in bulkiness (%)
Example 1	54
Comparative example 1	—

[0166] Table 1 shows that the tobacco sheet of Example 1, which is the tobacco sheet according to the present embodiment, had improved bulkiness as compared with the tobacco sheet without the wavy shape of Comparative Example 1.

[0167] The first embodiment is described below with reference to Reference Example A and Reference Comparative Example A.

Reference Example A1

[0168] A tobacco leaf was ground with a grinder (ACM-5 manufactured by Hosokawa Micron Corporation) so as to have a D90 of 204 μm and a D50 of 66 μm to produce leaf tobacco particles. D90 and D50 were measured with Mastersizer (manufactured by malvern). The leaf tobacco particles and a binder Sunrose F20HC (cellulose ether manufactured by Nippon Paper Industries Co., Ltd.) were dry-blended using a mixer. Glycerin as an aerosol-generating material and water as a medium were then added to the dry blend and were mixed using a mixer to prepare a wet powder. Table A1 shows the ratio of each component.

[0169] The wet powder was kneaded six times at room temperature using a kneading machine (DG-1 manufactured by Dalton Corporation) to prepare a mixture. A T-die was used as a die, and the screw speed was 38.5 rpm.

[0170] The wet powder was sandwiched between two Teflon (registered trademark) films (Nitoflon (registered trademark) No. 900UL manufactured by Nitto Denko Corporation) and was rolled in four stages to a predetermined thickness (more than 100 μm) using a calender (manufactured by Yuri Roll Machine Co., Ltd.) to prepare a laminate 105 μm in thickness with a layered structure of film/wet sheet/film. The roll gaps in the first to fourth stages were 650

μm, 330 μm, 180 μm, and 5 μm, respectively. The roll gap in the fourth stage was larger than the thickness of the finally formed sheet because the sheet released from the pressure between the rollers expanded close to the final thickness.

[0171] One of the Teflon (registered trademark) films was peeled off from the laminate, and the laminate was dried with a forced-air dryer at 80° C. for 1 to 2 minutes. The other film was then peeled off, and the wet sheet was dried under the same conditions to produce and evaluate a tobacco sheet according to the present invention.

TABLE A1-1

Formulation in Reference Example A1

	Ground tobacco leaves	Glycerin	Binder	Water
Charged weight ratio [WB wt %]	65	11	2	22
Water content of component [wt %]	10	13	5.4	100
Charged weight ratio [DB wt %] (composition of finished sheet)	83	14	3	—
Weight in wet powder [g]	180.7	31.54	6.2	61.5
Weight ratio in wet powder [WB wt %]	64.5	11.3	2.2	22.0

WB: wet basis
DB: dry basis

[0172] With respect to the mass in the wet powder in Table A1, the mass of ground tobacco leaves, glycerin, or the binder is a dry mass. The mass of water is the total of the mass of water charged and the mass of water in the ground tobacco leaves, glycerin, and binder.

Reference Examples A2 and A4

[0173] A tobacco sheet was produced and evaluated in the same manner as in Reference Example A1 except that Sunrose F30MC or Sunrose F20LC was used as the binder instead of Sunrose F20HC (cellulose ether manufactured by Nippon Paper Industries Co., Ltd.).

Reference Example A3

[0174] A tobacco sheet was produced and evaluated in the same manner as in Reference Example A1 except that Sunrose F30MC was used as the binder instead of Sunrose F20HC (cellulose ether manufactured by Nippon Paper Industries Co., Ltd.), the amount of Sunrose F30MC was changed as shown in Table A3, and the amount of glycerin was changed so as to be 15.5% by DB mass based on the charged mass.

Reference Comparative Example A1

[0175] Leaf tobacco particles with a D90 of 204 μm and a D50 of 66 μm were prepared in the same manner as in Reference Example A1. The same components as in Reference Example A1 and pulp were mixed using a mixer to prepare a mixture. The mixture was used to produce a tobacco sheet by the casting method in accordance with a routine method.

TABLE A1-2

Formulation in Reference Comparative Example A1

	Ground tobacco leaves	Pulp	Glycerin	Binder	Water
Charged weight ratio [WB wt %]	16.5	0.6	4.4	0.6	77.8
Water content of component [wt %]	9.07	8.66	13.00	6.27	100
Charged weight ratio [DB wt %] (composition of finished sheet)	75.0	3.0	19.0	3.0	—

Reference Comparative Example A2

[0176] A tobacco sheet was produced by a paper-making method in accordance with a routine method. More specifically, a water-soluble component of a tobacco raw material was extracted with water, and the extraction residue, pulp, and water were mixed and beaten with a grinder. A sheet was formed with a paper machine and was dried. The extract and glycerin were added to the sheet. The tobacco sheet was evaluated in the same manner as in Reference Example A1. Table A2 shows the composition of the sheet. Table A3 shows the evaluation results of the tobacco sheets produced in these examples.

TABLE A2

Formulation

	Tobacco material	Glycerin	Pulp
Composition of finished sheet [DB wt %]	74.3	18.7	7

TABLE A3

Physical properties of sheet

		Raw material particle diameter		Binder		Surface roughness	Tensile	Elongation	Amount of fallen
	Sheet	D50 [μm]	D90 [μm]	Type	Amount [wt %*]	Sa [μm]	strength [N/mm^2]	Percentage [%]	shreds [mm^3]
Reference Example A1	Laminate	66	204	F20HC	3	15.3	3.42	3.6	4.9
Reference Example A2	Laminate	66	204	F30MC	3	8.4	1.24	2.1	12.5
Reference Example A3	Laminate	66	204	F30MC	1.5	8.0	1.24	2.1	15.4

TABLE A3-continued

		Physical properties of sheet							
		Raw material particle diameter		Binder		Surface roughness	Tensile	Elongation	Amount of fallen
	Sheet	D50 [μm]	D90 [μm]	Type	Amount [wt %*]	Sa [μm]	strength [N/mm^2]	Percentage [%]	shreds [mm^3]
Reference Example A4	Laminate	66	204	F20LC	3	7.4	1.37	2.3	15.1
Reference Comparative Example A1	Cast	66	204	F30MC	3	35.1	2.83	2.9	45.5
Reference Comparative Example A2	Paper-making	—	—	—	—	38.0	0.96	2.03	—

*Dry weight basis (DB)

[0177] Evaluation methods are described below.

[Volume of Fallen Shreds]

[0178] The tobacco sheet prepared in each example was cut to prepare shreds. The shreds were packed at 70% by volume in a wrapper **22** with a length of 12 mm and a diameter of 7 mm to prepare a tobacco segment **20**A. A flavor inhalation article **1** illustrated in FIG. **2** including the tobacco-containing segment was then produced. A system illustrated in FIG. **3** (internal heating type) was prepared and subjected to a smoking test using a smoking machine (14 puffs, CIR conditions, constant heating at 350° C.). After the smoking test, the shreds were gently removed from the tobacco segment **20**A. The shreds were then packed again in the wrapper **22** at the above volume percent and were subjected to the second smoking test. The smoking test was performed 20 times in total in this manner, and the total volume of fallen shreds remaining in the wrapper **22** was measured.

[Surface Roughness]

[0179] Measurement was performed with a microscope (VK-X100 manufactured by KEYENCE) by the following procedure.

[0180] 1) Set the focal position of the lowest portion of the sheet

[0181] 2) Set the focal position of the highest portion of the sheet

[0182] 3) Divide the section obtained in **1**) and **2**) and take an image while gradually shifting the focus

[0183] 4) Measure the height from the difference between the focal position of each portion and the focal position of the lowest portion

[0184] 5) Calculate (automatically calculate using measuring machine software) roughness from height data at each position and calculate arithmetic surface roughness Sa

[Tensile Strength, Elongation Percentage]

[0185] The sheet was cut into 15 mm in width×180 mm in length and was subjected to measurement using a tensile strength tester (Strograph E-S manufactured by Toyo Seiki Seisaku-Sho, Ltd.) under the conditions of ROADRANGE: 25 and SPEEDRANGE: 50, and the tensile strength was evaluated by tensile stress.

[0186] The second embodiment is described below with reference to Reference Example B and Reference Comparative Example B.

Reference Example B1

[0187] A tobacco leaf was ground with a grinder (ACM-5 manufactured by Hosokawa Micron Corporation) so as to have a D90 in the range of 50 to 800 μm to produce leaf tobacco particles. D90 was measured with Mastersizer (manufactured by malvern). The leaf tobacco particles and a binder carboxymethyl cellulose (Sunrose F F30MC manufactured by Nippon Paper Industries Co., Ltd.) were dry-blended using a mixer. Glycerin as an aerosol-generating material and water as a medium were then added to the dry blend and were mixed using a mixer to prepare a wet powder. The ratio of each component is described below.

TABLE B1

Formulation				
	Ground tobacco leaves	Glycerin	Binder	Water
Charged weight ratio [WB wt %]	65	11	2	22
Water content of component [wt %]	10	13	5.4	100
Charged weight ratio [DB wt %]	83	14	3	—
Weight in wet powder [g]	180.7	31.54	6.2	61.5
Weight ratio in wet powder [WB wt %]	64.5	11.3	2.2	22.0

WB: wet basis
DB: dry basis

[0188] With respect to the mass in the wet powder in Table B1, the mass of ground tobacco leaves, glycerin, or the binder is a dry mass. The mass of water is the total of the mass of water charged and the mass of water in the ground tobacco leaves, glycerin, and binder.

[0189] The wet powder was kneaded six times at room temperature using a kneading machine (DG-1 manufactured by Dalton Corporation) to prepare a mixture. The die shape was a T shape (T-die), and the screw speed was 38.5 rpm.

[0190] The wet powder was sandwiched between two Teflon (registered trademark) films (Nitoflon (registered trademark) No. 900UL manufactured by Nitto Denko Corporation) and was rolled in four stages to a predetermined thickness (more than 100 μm) using a calender (manufactured by Yuri Roll Machine Co., Ltd.) to prepare a laminate 105 μm in thickness with a layered structure of film/wet sheet/film. The roll gaps in the first to fourth stages were 650 μm, 330 μm, 180 μm, and 5 μm, respectively. The roll gap in the fourth stage was larger than the thickness of the finally formed sheet because the sheet released from the pressure between the rollers expanded close to the final thickness.

[0191] One of the Teflon (registered trademark) films was peeled off from the laminate, and the laminate was dried with a forced-air dryer at 80° C. for 1 to 2 minutes. The other film was then peeled off, and the wet sheet was dried under the same conditions to produce a tobacco sheet according to the present embodiment.

Reference Examples B2 to B5

[0192] A tobacco sheet was produced and evaluated in the same manner as in Reference Example B1 except that a carboxymethyl cellulose (manufactured by Nippon Paper Industries Co., Ltd.) shown in Table B2 was used as the binder.

Reference Comparative Example B1

[0193] A tobacco sheet was produced and evaluated in the same manner as in Reference Example B1 except that a carboxymethyl cellulose (manufactured by Nippon Paper Industries Co., Ltd.) shown in Table B2 was used as the binder. Table B3 shows the results. In the table, the physical properties of the finished sheet are the physical properties of a sheet produced through drying as described above and not dried to the absolute dry state.

TABLE B2

Composition and physical properties of sheet						
		Physical properties of binder		Physical properties of finished sheet		
	Binder	Degree of substitution [mol/C6]	Viscosity** [mPa · s]	Basis weight [g-WB/m^2]	Thickness [μm]	Density [g-WB/mL]
Reference Comparative Example B1	F20LC 3%	0.62	250	163	133	1.23
Reference Example B1	F30MC 3%	0.72	350	165	134	1.23
Reference Example B2	F20HC 3%	0.89	250	149	120	1.24
Reference Example B3	A04SH 3%	more than 1.30*	60	217	177	1.23
Reference Example B4	A20SH 3%	more than 1.30*	250	228	191	1.19

*Manufacturer's nominal value

**Manufacturer's nominal value (OD 1% aqueous solution viscosity)

TABLE B3

Physical properties of sheet					
		Sa (mm)	Tensile strength (N/mm)	Coagulability after heating (N)	Volume of fallen shreds (mm^3)
Reference Example	B1	—	1.8	29	9.5
	B2	0.015	3.4	39	5
Reference Comparative Example	B1	0.035	1.3	16	15

Evaluation Methods are Described Below.

[Volume of Fallen Shreds]

[0194] The tobacco sheet prepared in each example was cut to prepare shreds. The shreds were packed at 70% by volume in a wrapper **22** with a length of 12 mm and a diameter of 7 mm to prepare a tobacco-containing segment **20**A. A flavor inhalation article **1** illustrated in FIG. **2** including the tobacco-containing segment was then produced. A system illustrated in FIG. **3** (internal heating type) was prepared and subjected to a smoking test using a smoking machine (14 puffs, CIR conditions, constant heating at 350° C.). After the smoking test, the shreds were gently removed from the tobacco segment **20**A. The shreds were then packed again in the wrapper **22** at the above volume percent and were subjected to the second smoking test. The smoking test was performed 20 times in total in this manner, and the total volume of fallen shreds remaining in the wrapper **22** was measured.

[Surface Roughness]

[0195] Measurement was performed with a microscope (VK-X100 manufactured by KEYENCE) by the following procedure.

[0196] 1) Set the focal position of the lowest portion of the sheet

[0197] 2) Set the focal position of the highest portion of the sheet

[0198] 3) Divide the section obtained in **1**) and **2**) and take an image while gradually shifting the focus

[0199] 4) Measure the height from the difference between the focal position of each portion and the focal position of the lowest portion

[0200] 5) Calculate (automatically calculate using measuring machine software) roughness from height data at each position and calculate arithmetic surface roughness Sa

[Coagulability after Heating]

[0201] A non-combustion internal-heating-type smoking system was prepared under the conditions described in the volume of fallen shreds, and the smoking test was performed once under the same conditions. After the test, the tobacco segment **20**A was taken out from the system. A jig was brought into contact with a position of 6 mm in the longitudinal direction from the tip of the tobacco segment **20**A, and the tobacco segment **20**A was compressed in the radial direction at a constant speed. The load (N) at the point in time when the jig reached a position of 3.5 mm was determined to evaluate coagulability after heating. A higher load indicates that shreds are more likely to be fastened after heating and are less likely to fall off.

[Tensile Strength]

[0202] The sheet was cut into 15 mm in width×180 mm in length and was subjected to measurement using a tensile strength tester (Strograph E-S manufactured by Toyo Seiki Seisaku-Sho, Ltd.) under the conditions of ROADRANGE: 25 and SPEEDRANGE: 50, and the tensile strength was evaluated by tensile stress.

[Degree of Substitution]

[0203] It was determined by the measurement method described above.

[0204] The aspects are described below.

[0205] [1] A tobacco sheet for a non-combustion heating-type flavor inhaler, wherein the tobacco sheet contains a tobacco raw material and has a wavy shape in a cross-section in a thickness direction.

[0206] [2] The tobacco sheet for a non-combustion heating-type flavor inhaler according to [1], wherein the tobacco sheet further contains an aerosol generator.

[0207] [3] The tobacco sheet for a non-combustion heating-type flavor inhaler according to [2], wherein the aerosol generator is at least one selected from the group consisting of glycerin, propylene glycol, and 1,3-butanediol.

[0208] [4] The tobacco sheet for a non-combustion heating-type flavor inhaler according to [2] or [3], wherein the aerosol generator content per 100% by mass of the tobacco sheet ranges from 4% to 50% by mass.

[0209] [5] The tobacco sheet for a non-combustion heating-type flavor inhaler according to any one of [1] to [4], wherein the tobacco sheet further contains a first shaping agent and a second shaping agent.

[0210] [6] The tobacco sheet for a non-combustion heating-type flavor inhaler according to [5], wherein the first shaping agent is at least one selected from the group consisting of polysaccharides, proteins, and synthetic polymers.

[0211] [7] The tobacco sheet for a non-combustion heating-type flavor inhaler according to [5] or [6], wherein the second shaping agent is at least one selected from the group consisting of polysaccharides, proteins, and synthetic polymers, which is different from the first shaping agent.

[0212] [8] The tobacco sheet for a non-combustion heating-type flavor inhaler according to any one of [5] to [7], wherein the first shaping agent content per 100% by mass of the tobacco sheet ranges from 0.1% to 15% by mass.

[0213] [9] The tobacco sheet for a non-combustion heating-type flavor inhaler according to any one of [5] to [8], wherein the second shaping agent content per 100% by mass of the tobacco sheet ranges from 0.1% to 15% by mass.

[0214] [10] A non-combustion heating-type flavor inhaler including a tobacco-containing segment containing the tobacco sheet for a non-combustion heating-type flavor inhaler according to any one of [1] to [9].

[0215] [11] A non-combustion heating-type flavor inhaling system including:

[0216] the non-combustion heating-type flavor inhaler according to [10]; and

[0217] a heating device for heating the tobacco-containing segment.

[0218] [12] A method for manufacturing the tobacco sheet for a non-combustion heating-type flavor inhaler according to any one of [1] to [9], the method including:

[0219] preparing a mixture containing the tobacco raw material, an aerosol generator, a first shaping agent, and a second shaping agent;

[0220] rolling the mixture to form a rolled product; and

[0221] pressing a rotary roll blade against the rolled product to cut the rolled product into a strip while imparting a wavy shape to the strip.

[0222] [1A] A tobacco sheet containing a tobacco material and a binder, wherein at least one surface of the tobacco sheet has an arithmetic mean surface roughness Sa in the range of 5 to 30 μm.

[0223] [2A] The sheet according to [1A], which is a press-formed sheet.

[0224] [3A] The sheet according to [1A] or [2A], wherein the binder constitutes 6% by mass or less based on dry mass with respect to the dry mass of the tobacco sheet.

[0225] [4A] The tobacco sheet according to [1A], wherein both surfaces thereof have an arithmetic mean surface roughness Sa in the range of 5 to 30 μm.

[0226] [5A] The sheet according to any one of [1A] to [4A], having a tensile elongation in the range of 5% to 15%.

[0227] [6A] A non-combustion heating-type smoking article containing the tobacco sheet according to any one of [1A] to [5A] or a material derived therefrom.

[0228] [7A] A method for manufacturing the sheet according to any one of [1A] to [5A], including:

[0229] step 1 of kneading at least a tobacco material, a binder, and a medium to prepare a mixture;

[0230] step 2 of pressure-extending the mixture or extruding the mixture through a die to prepare a wet sheet; and

[0231] step 3 of drying the wet sheet.

[0232] [8A] The manufacturing method according to [7A], wherein the step 2 includes preparing a laminated sheet including a wet sheet between two substrate films.

[0233] [9A] The manufacturing method according to [7A] or [8A], wherein the step 1 includes kneading at least the tobacco material, the binder, and the medium using a single-screw or multi-screw kneading machine.

[0234] [10A] The manufacturing method according to any one of [7A] to [9A], wherein the mixture contains 20% to 80% by mass of the medium based on the total amount of the mixture.

[0235] [1B] A tobacco sheet containing:

[0236] a tobacco material; and

[0237] a cellulose derivative with a degree of substitution of 0.65 or more.

[0238] [2B] The sheet according to [1B], wherein the degree of substitution is 0.7 or more.

[0239] [3B] The sheet according to [2B], wherein the degree of substitution is 0.8 or more.

[0240] [4B] The sheet according to any one of [1B] to [3B], wherein the cellulose derivative is a carboxyalkylated cellulose.

[0241] [5B] The sheet according to any one of [1B] to [4B], wherein the arithmetic mean surface roughness Sa is 0.03 mm or less.

[0242] [6B] The sheet according to any one of [1B] to [5B], which is a press-formed sheet.

[0243] [7B] A method for manufacturing the sheet according to any one of [1B] to [6B], the method including:

[0244] step 1 of preparing a mixture containing at least a tobacco material, the cellulose derivative, and a medium;

[0245] step 2 of spreading the mixture on a substrate to prepare a wet sheet; and

[0246] step 3 of drying the wet sheet.

[0247] [8B] The manufacturing method according to [7B], wherein the step 1 includes kneading the tobacco material, the cellulose derivative, and the medium using a single-screw or multi-screw kneading machine.

[0248] [9B] The manufacturing method according to [7B] or [8B], wherein the step 2 includes pressure-extending the mixture using a roller or extruding the mixture through a die.

[0249] [10B] The manufacturing method according to [9B], wherein the step 2 includes preparing a laminated sheet including a wet sheet between two substrate films.

[0250] [11B] A non-combustion heating-type smoking article containing the tobacco sheet according to any one of [1B] to [6B] or a material derived therefrom.

REFERENCE SIGNS LIST

[0251] **1** tobacco sheet
[0252] **2** wave
[0253] **3** serrated shape
[0254] **4** non-combustion heating-type flavor inhaler
[0255] **5** tobacco-containing segment
[0256] **6** cooling segment
[0257] **7** center hole segment
[0258] **8** filter segment
[0259] **9** mouthpiece segment
[0260] **10** tubular member
[0261] **11** hole
[0262] **12** second fill layer
[0263] **13** second inner plug wrapper
[0264] **14** outer plug wrapper
[0265] **15** mouthpiece lining paper
[0266] **16** heating device
[0267] **17** body
[0268] **18** heater
[0269] **19** metal tube
[0270] **20** battery unit
[0271] **21** control unit
[0272] **22** recess
[0273] **200**A tobacco-containing segment
[0274] **210** filler
[0275] **220** wrapper
[0276] T tobacco sheet
[0277] a a region between two peaks that determine the period of a wave in a cross-section

1. A tobacco sheet for a non-combustion heating-type flavor inhaler, wherein the tobacco sheet contains a tobacco raw material and has a wavy shape in a cross-section in a thickness direction,

wherein at least one of an arcuate curved surface present on a front surface and an arcuate curved surface present on a back surface of the sheet has a surface arithmetic mean surface roughness Sa in the range of 5 to 30 μm.

2. (canceled)

3. The sheet according to claim **1**, which is a press-formed sheet.

4. The sheet according to claim **1**, comprising a cellulose derivative with a degree of substitution of 0.65 or more.

5. The sheet according to claim **4**, wherein the degree of substitution is 0.7 or more.

6. A non-combustion heating-type flavor inhaler comprising a tobacco-containing segment containing the tobacco sheet for a non-combustion heating-type flavor inhaler according to claim **1**.

7. A non-combustion heating-type flavor inhaling system comprising:

the non-combustion heating-type flavor inhaler according to claim **6**; and

a heating device for heating the tobacco-containing segment.

8. A method for manufacturing the tobacco sheet according to claim **1**, comprising:

preparing a mixture containing the tobacco raw material, an aerosol generator, a first shaping agent, and a second shaping agent;

rolling the mixture to form a rolled product; and

pressing a rotary roll blade against the rolled product to cut the rolled product into a strip while imparting a wavy shape to the strip.

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