

## DESCRIPTION

Title of the Invention: WIPING SHEET

Technical Field

[0001]

5           The present invention relates to a wiping sheet.

Background Art

[0002]

10           Fibers made from a thermoplastic resin are used for various purposes in the form of a nonwoven fabric in which the fibers are entangled. For example, Patent Literature 1 discloses a processed fabric for cleaning, and the processed fabric includes a fiber entangled body mainly containing ultrafine fibers that have an average fiber diameter of 0.3 to 3.0  $\mu\text{m}$  and have a modified cross section. The literature discloses that the processed fabric for cleaning is used for cleaning the surface of a substrate for a magnetic recording medium.

15           [0003]

20           Patent Literature 2 discloses a nonwoven fabric including 20 to 80% by mass of polyester fibers having an oblate multilobal cross section and 20 to 80% by mass of cellulose fibers. The literature discloses that the nonwoven fabric has high absorption, retention, and release properties of liquids such as water and chemical solutions, also has an appropriate bulkiness and softness, and thus can be used for human cleansing and cosmetic wiper applications.

Citation List

Patent Literatures

[0004]

25           Patent Literature 1: JP 2013-124422 A

Patent Literature 2: US 2015/359400 A1

Summary of Invention

[0005]

The present invention relates to a wiping sheet including a fiber aggregate that at least contains first fibers and second fibers having a smaller diameter than that of the first fibers, and these fibers are entangled in the fiber aggregate. The wiping sheet has a first surface and a second surface located opposite to the first surface. In the wiping sheet, the second fibers are present at a higher proportion on the first surface than on the second surface. In the wiping sheet, at least the first fibers are modified cross section fibers having a non-circular lateral cross section.

#### Brief Description of Drawings

[0006]

[Fig. 1] Fig. 1 is a schematic cross-sectional view showing an embodiment of a wiping sheet of the present invention.

[Figs. 2] Figs. 2(a) and 2(e) are schematic perspective views showing lateral cross-sectional shapes of modified cross section fibers used in the wiping sheet of the present invention.

[Figs. 3] Fig. 3(a) to 3(c) are enlarged plan views of the lateral cross-sectional shapes of the modified cross section fibers in Figs. 1(b), 1(d), and 1(e).

[Fig. 4] Fig. 4 is a schematic view showing an embodiment of an uneven portion with a macroscopic pattern on a first surface of the wiping sheet of the present invention.

[Fig. 5] Fig. 5 is a schematic view of a production apparatus suitably used for production of the wiping sheet of the present invention.

[Fig. 6] Fig. 6 is a schematic view of an uneven portion forming member for forming an uneven portion with a macroscopic pattern.

#### Description of Embodiments

[0007]

The processed fabric for cleaning and the nonwoven fabric according to Patent Literatures 1 and 2 are for cleaning a substrate surface or for human cleansing and cosmetic wiper applications, and the literatures disclose no dust collection performance when floor cleaning or the like is performed. A nonwoven fabric or the like containing ultrafine fibers has insufficient strength, and consequently such a sheet is likely to break at the time of use.

[0008]

The present invention therefore relates to a wiping sheet that overcomes conventional disadvantages.

[0009]

5           A wiping sheet of the present invention will now be described on the basis of preferred embodiments thereof. In the present invention, “wiping” includes both meanings of cleaning and cleansing and, for example, includes building cleaning such as floor, wall, ceiling, and pillar cleaning, cleaning of fittings and fixtures, wiping of articles, and cleansing of human bodies and apparatuses for human bodies. In the present  
10 description, a “wiping sheet” simply called means a sheet supporting a cleaning liquid or a sheet supporting no cleaning liquid, depending on context.

[0010]

          The wiping sheet includes a fiber aggregate at least containing first fibers and second fibers having a smaller diameter than that of the first fibers. The first fibers and  
15 the second fibers form the fiber aggregate in which the first fibers are entangled with each other, the second fibers are entangled with each other, and the first fibers are entangled with the second fibers. In other words, the fiber aggregate used in the wiping sheet is a complexed fiber aggregate mainly including an entangled body of the first and the second fibers. The wiping sheet may consist of only the fiber aggregate or may include, in  
20 addition to the fiber aggregate, one or both of an additional sheet material and an additional member. The wiping sheet of the present invention may be a fiber aggregate supporting no cleaning liquid (hereinafter, the embodiment is also called “dry sheet”) or may be a fiber aggregate supporting a cleaning liquid (hereinafter, the embodiment is also called “wet sheet”).

25   [0011]

          Fig. 1 is a cross-sectional view of a fiber aggregate included in a wiping sheet of the present invention. As shown in the figure, a fiber aggregate 1A in a wiping sheet 1 includes first fibers 11 and second fibers 12 having a smaller diameter than that of the first fibers. The wiping sheet 1 has a first surface 1F and a second surface 1R located  
30 opposite to the first surface 1F. As shown in Fig. 1, in the wiping sheet 1, on the first

surface 1F in the figure, the second fibers 12 that are fibers having a smaller fiber diameter are mainly present, whereas on the second surface 1R, the first fibers 11 are mainly present. The first surface 1F is served as a wiping surface when the wiping sheet is used. The “being mainly present” means that when a vertical cross section of a wiping sheet 1 in the thickness direction Z is viewed, fibers referred are present at the highest proportion on the corresponding surface.

[0012]

The proportion of the second fibers 12 on the first surface 1F in terms of area percentage is preferably 40% or more, more preferably 50% or more, and even more preferably 60% or more and is preferably 100% or less, more preferably 90% or less, and even more preferably 85% or less. The proportion of the second fibers 12 on the first surface 1F in terms of area percentage is preferably 40% or more and 100% or less, more preferably 50% or more and 90% or less, and even more preferably 60% or more and 85% or less. A sheet having such a proportion has a dense and low-porosity structure formed from small diameter fibers, thus has higher collection performance for particulate dust, and has higher sheet strength at the time of use. In addition, a wet sheet having the structure has higher sustained release performance of a cleaning liquid.

[0013]

The proportion of the first fibers 11 on the first surface 1F in terms of area percentage is preferably 0% or more, more preferably 1% or more, and even more preferably 5% or more and is preferably 60% or less, more preferably 40% or less, and even more preferably 35% or less. The proportion of the first fibers 11 on the first surface 1F in terms of area percentage is preferably 0% or more and 60% or less, more preferably 1% or more and 40% or less, and even more preferably 5% or more and 35% or less. A sheet having such a proportion has a high-porosity structure formed from large diameter fibers, thus has higher collection performance for fiber dust such as hair, and has higher sheet strength at the time of use. In addition, a wet sheet having the structure has higher sustained release performance of a cleaning liquid.

[0014]

Similarly, the proportion of the second fibers 12 on the second surface 1R in

terms of area percentage is preferably 1% or more, more preferably 3% or more, and even more preferably 5% or more and is preferably 60% or less, more preferably 40% or less, and even more preferably 35% or less. The proportion of the second fibers 12 on the second surface 1R in terms of area percentage is preferably 1% or more and 60% or less, more preferably 3% or more and 40% or less, and even more preferably 5% or more and 35% or less.

[0015]

Similarly, the proportion of the first fibers 11 on the second surface 1R in terms of area percentage is preferably 50% or more, more preferably 65% or more, and even more preferably 70% or more and is preferably 100% or less, more preferably 90% or less, and even more preferably 87% or less. The proportion of the first fibers 11 on the second surface 1R in terms of area percentage is preferably 50% or more and 100% or less, more preferably 65% or more and 90% or less, and even more preferably 70% or more and 87% or less.

[0016]

The proportions of the first fibers 11 and the second fibers 12 on each surface may be determined, for example, by using a confocal laser scanning microscope in terms of area percentage. Specifically, the first surface 1F or the second surface 1R is observed to give an image data. The resulting image is binarized by using an image processing software such as ImageJ while a threshold is set for the brightness boundary between the first fibers and the second fibers. The area of each color is then calculated, and the area percentage of the corresponding fibers is determined.

[0017]

In the wiping sheet, on imaginary faces parallel with the first surface 1F, the proportion of the second fibers 12 in terms of area percentage preferably decreases toward the surface opposite to the first surface 1F in the thickness direction Z, step-by-step, continuously, or a combination manner thereof. In particular, when the proportion of the second fibers 12 on an imaginary face parallel with the first surface 1F in terms of area percentage is in a range of 50% or more and 100% or less in a portion of the wiping sheet having a thickness of 50% or more and 100% or less in the thickness direction Z of the

wiping sheet where the second surface 1R is considered as the base (zero-face), the sheet strength and the dust collection performance can be improved. In addition, a wet sheet having the structure has higher sustained release performance of a cleaning liquid.

[0018]

5           The thickness percentage of the sheet in which the proportion of the second fibers is in a range of 50% or more and 100% or less is preferably 1% or more and 90% or less, more preferably 5% or more and 70% or less, and even more preferably 7% or more and 50% or less. The proportion may be calculated as the above-described area percentage by Raman imaging in a sheet thickness direction by using a confocal laser  
10 scanning microscope, for example.

[0019]

          In the wiping sheet of the present invention, at least the first fibers 11 having a larger diameter are modified cross section fibers. The modified cross section fibers have a non-circular lateral cross section. Fibers having a non-circular lateral cross section  
15 means that the fibers have a lateral cross section with a shape other than the perfect circular shape. From the viewpoint of effectively achieving sheet strength and dust collection performance, at least the first fibers 11 having a larger diameter are preferably modified cross section fibers, and both the first fibers and the second fibers are more preferably modified cross section fibers.

20       [0020]

          Examples of the modified cross section fiber having such a fiber lateral cross-sectional shape include fibers having a triangular shape shown in Fig. 2(a), fibers having a convex polygonal shape or a regular polygonal shape such as a quadrangular shape, a pentagonal shape, and a hexagonal shape, fibers having a star polygonal shape  
25 shown in Fig. 2(b), fibers having an elliptical shape shown in Fig. 2(c), fibers having a W shape shown in Fig. 2(d), and fibers having a multilobal shape shown in Fig. 2(e), as the lateral cross-sectional shape, but are not specifically limited as long as the effect of the present invention is achieved.

[0021]

The first fibers 11 are modified cross section fibers having a lateral cross-sectional shape that preferably has at least one, more preferably two or more, and even more preferably three or more projecting portions each having a sharp apex. As the outline of a projecting portion in a lateral cross-sectional shape of a modified cross section fiber, examples of the sharp apex includes (A) a sharp apex defined by intersection of two straight lines that are not parallel, (B) a sharp apex defined by intersection of a straight line and a curved line, and (C) a sharp apex defined by intersection of two curved lines. For example, the modified cross section fiber shown in Fig. 2(a) has three sharp apexes, the modified cross section fiber shown in Fig. 2(b) has six sharp apexes, and the modified cross section fiber shown in Fig. 2(e) has eight sharp apexes. In the present invention, a single type of modified cross section fibers may be used, or two or more types of modified cross section fibers having different lateral cross-sectional shapes may be used in combination.

[0022]

The wiping sheet of the present invention includes modified cross section fibers as constituent fibers thereof and accordingly has a high tensile elastic modulus. From the viewpoint of making the wiping sheet have higher strength, the tensile elastic modulus of the wiping sheet is preferably  $1.3 \times 10^{-3}$  N/mm<sup>2</sup> or more, more preferably  $1.4 \times 10^{-3}$  N/mm<sup>2</sup> or more, and even more preferably  $1.5 \times 10^{-3}$  N/mm<sup>2</sup> or more. The upper limit of the tensile elastic modulus is not specifically limited but is practically  $5.0 \times 10^{-3}$  N/mm<sup>2</sup> or less. The tensile elastic modulus may be determined, for example, from a difference in tensile strength (N/mm) between two sites and a difference in displacement (mm) between these tensile strengths. The measurement method will be described later in examples.

[0023]

From the viewpoint of achieving both the sheet strength and the dust collection efficiency at high levels, the first fibers preferably have a higher fineness (dtex) than the fineness (dtex) of the second fibers. Specifically, the ratio of the fineness (dtex) of the first fibers to the fineness (dtex) of the second fibers is preferably 10 or more, more preferably 15 or more, and even more preferably 25 or more and is preferably 2,000 or less, more preferably 1,500 or less, and even more preferably 1,000 or less.

[0024]

From a similar viewpoint, the fineness of the first fibers contained in the wiping sheet is preferably 0.5 dtex or more, more preferably 1 dtex or more, and even more preferably 1.2 dtex or more, and the upper limit is preferably 3 dtex or less, more  
5 preferably 2.5 dtex or less, and even more preferably 2 dtex or less.

[0025]

From a similar viewpoint, the fineness of the second fibers contained in the wiping sheet is preferably  $1.5 \times 10^{-3}$  dtex or more, more preferably  $2.5 \times 10^{-3}$  dtex or more, and even more preferably  $4.5 \times 10^{-3}$  dtex or more. The fineness of the second  
10 fibers is preferably  $3.0 \times 10^{-1}$  dtex or less, more preferably  $1.0 \times 10^{-1}$  dtex or less, and even more preferably  $5.0 \times 10^{-2}$  dtex or less.

[0026]

The first fibers 11 and the second fibers 12 included in the wiping sheet 1 may be either synthetic fibers or natural fibers, but from the viewpoint of easy formability and  
15 production efficiency of the fibers, at least the first fibers are preferably synthetic fibers made from a thermoplastic resin, and both the fibers 11 and 12 are more preferably synthetic fibers made from a thermoplastic resin.

[0027]

Examples of the thermoplastic resin include polyolefin resins such as  
20 polyethylene (PE) and polypropylene (PP), polyester resins such as polyethylene terephthalate (PET), polyamide resins, vinyl resins such as polyvinyl chloride and polystyrene, acrylic resins such as polyacrylic acid and polymethyl methacrylate, and fluorine resins such as polyperfluoroethylene. Examples of the natural fibers include  
various cellulose fibers including hydrophilic fibers such as pulp, cotton, rayon, lyocell,  
25 and tencel. These types of fibers may be used singly or in combination of two or more of them.

[0028]

From the viewpoint of improving the degree of freedom of the constituent fibers and of improving dust collection performance, the fibers included in the wiping sheet are

preferably entangled without bonding to each other. A sheet having such structure can have higher dust collection performance while maintaining the sheet strength. In addition, when used as a wet sheet, the wiping sheet advantageously supports a larger amount of a cleaning liquid per unit area.

5 [0029]

The fiber length of the first fibers varies depending on fiber production methods but is preferably 1 mm or more and 100 mm or less, more preferably 10 mm or more and 90 mm or less, and even more preferably 20 mm or more and 60 mm or less. The fiber length of the second fibers varies depending on fiber production methods but is preferably  
10 1 mm or more. Examples of the production method of the first fibers 11 and the second fibers 12 include spunbonding, melt blowing, and electrospinning. From the viewpoint of further improving the production efficiency of small diameter fibers, at least the second fibers are preferably synthetic fibers made from a thermoplastic resin and are preferably produced by electrospinning.

15 [0030]

When, of the line segments crossing the lateral cross section of a modified cross section fiber, the longest line segment has a length A, and of the line segments that are orthogonal to the above longest line segment and crosses the lateral cross section, the longest line segment has a length B (see Figs. 3(a) to 3(c)), the ratio of the length A to the  
20 length B ( $A/B$ ) is preferably 1.2 or more, more preferably 1.5 or more, and even more preferably 2 or more, and the upper limit is preferably 5 or less, more preferably 4 or less, and even more preferably 3 or less. Specifically, the value  $A/B$  is preferably 1.2 or more and 5 or less, more preferably 1.5 or more and 4 or less, and even more preferably 2 or more and 3 or less. When fibers have such a structure, the fibers included in a wiping  
25 sheet are likely to tangle with fiber dust such as hair, and the dust can be caught by the fibers and be removed from an object surface to be wiped.

[0031]

As for the above length A and the length B, in a modified cross section fiber having a regular triangular shape as the fiber lateral cross-sectional shape (see Fig. 2(a))  
30 as an example lateral cross-sectional shape other than the shapes shown in Figs. 3(a) to

3(c), the length A is a length of one side of the regular triangle, and the length B is a length of the perpendicular line from an apex to the corresponding side. In a modified cross section fiber having an elliptical shape as the fiber lateral cross-sectional shape (see Fig. 2(c)), the length A is a major axis length of the ellipse, and the length B is a minor axis length of the ellipse.

[0032]

For a wiping sheet containing two or more types of modified cross section fibers having different lateral cross-sectional shapes, the above lengths A and B are the average of lengths A and the average of lengths B of the respective types of the modified cross section fibers.

[0033]

From the viewpoint of satisfying both the operability and the dust collection performance at the time of wiping, the length A is preferably 1  $\mu\text{m}$  or more, more preferably 5  $\mu\text{m}$  or more, and even more preferably 10  $\mu\text{m}$  or more, and the upper limit is preferably 80  $\mu\text{m}$  or less, more preferably 50  $\mu\text{m}$  or less, and even more preferably 25  $\mu\text{m}$  or less, provided that the above range of A/B is satisfied. From a similar viewpoint, the length B is preferably 0.2  $\mu\text{m}$  or more, more preferably 1  $\mu\text{m}$  or more, and even more preferably 2  $\mu\text{m}$  or more, and the upper limit is preferably 40  $\mu\text{m}$  or less, more preferably 20  $\mu\text{m}$  or less, and even more preferably 15  $\mu\text{m}$  or less, provided that the above range of A/B is satisfied.

[0034]

As shown in Figs. 3(a) to 3(c), for a modified cross section fiber having a lateral cross section that has a plurality of projecting portions P and recessed portions R between the adjacent projecting portions P when the outline of the lateral cross section is viewed in the circumferential direction, where the line segment between the apexes of the adjacent projecting portions P has a length C, and the perpendicular line from the line segment to the bottom of the corresponding recessed portion R has a length D (see Figs. 3(a) to 3(c)), the value C/D is preferably 0.1 or more, more preferably 1 or more, and even more preferably 2 or more, and the upper limit is preferably 5 or less, more preferably 4 or less, and even more preferably 3 or less. A fiber having such a structure has a larger surface

area and accordingly has a larger area to come into contact with dust, and thus the dust collection performance can be further improved.

[0035]

When the lateral cross section of a modified cross section fiber is observed, and  
5 line segments between apexes of any adjacent projecting portions P have various lengths C, the value C for calculating the value C/D is an average of all the values C. Similarly, when perpendicular lines for any recessed portions R have various lengths D, the value D for calculating the value C/D is an average of all the values D. In the following description, values for C and D are averages of C and D, respectively.

10 [0036]

From the viewpoint of improving the operability and the dust collection efficiency at the time of wiping, the length C is preferably 0.1  $\mu\text{m}$  or more, more preferably 0.5  $\mu\text{m}$  or more, and even more preferably 1  $\mu\text{m}$  or more, and the upper limit is preferably 20  $\mu\text{m}$  or less, more preferably 10  $\mu\text{m}$  or less, and even more preferably 5  $\mu\text{m}$   
15 or less, provided that the above range of C/D is satisfied. From a similar viewpoint, the length D is preferably 0.1  $\mu\text{m}$  or more, more preferably 0.5  $\mu\text{m}$  or more, and even more preferably 1  $\mu\text{m}$  or more, and the upper limit is preferably 20  $\mu\text{m}$  or less, more preferably 10  $\mu\text{m}$  or less, and even more preferably 5  $\mu\text{m}$  or less, provided that the above range of C/D is satisfied.

20 [0037]

The above lengths A to D may be determined by the following measurement method. In other words, a prepared fiber aggregate is cut by using a razor or the like while a fiber cross-sectional shape is maintained, and the cross section is vacuum-deposited with Pt. Under a scanning electron microscope (manufactured by  
25 JEOL Ltd., JSM-IT100), the Pt-deposited cross section of the fiber aggregate is observed at a magnification of 500 to 1,000 times, and an accompanying software, length measurement tool, is used to determine the lengths A to D in the fiber cross section.

[0038]

The wiping sheet of the present invention may consist of only the first fibers 11

and the second fibers 12 or may further include, in addition to these fibers, additional fibers. As the additional fibers, the synthetic fibers or the natural fibers described above may be used. These types of fibers may be used singly or in combination of two or more of them. The additional fibers may have a circular lateral cross section (non-modified cross section fibers) or may have a non-circular lateral cross section (modified cross section fibers). In the fiber aggregate, the additional fibers are preferably contained at a proportion of 50% by mass or less, more preferably at a proportion of 40% by mass or less, and even more preferably at a proportion of 30% by mass or less.

[0039]

10 When the wiping sheet of the present invention contains additional fibers, the fineness of the fibers is preferably 0.6 dtex or more, more preferably 1.0 dtex or more, and even more preferably 1.2 dtex or more, from the viewpoint of operability and dust collection efficiency at the time of wiping. The fineness is preferably 4.0 dtex or less, more preferably 3.5 dtex or less, and even more preferably 3.0 dtex or less.

15 [0040]

From the viewpoint of making the wiping sheet have an appropriate strength, the basis weight of the fiber aggregate included in the wiping sheet is preferably 40 g/m<sup>2</sup> or more, more preferably 45 g/m<sup>2</sup> or more, and even more preferably 50 g/m<sup>2</sup> or more, and the upper limit is preferably 140 g/m<sup>2</sup> or less, more preferably 100 g/m<sup>2</sup> or less, and even more preferably 80 g/m<sup>2</sup> or less. Specifically, the basis weight of the fiber aggregate included in the wiping sheet is preferably 40 g/m<sup>2</sup> or more and 140 g/m<sup>2</sup> or less, more preferably 45 g/m<sup>2</sup> or more and 100 g/m<sup>2</sup> or less, and even more preferably 50 g/m<sup>2</sup> or more and 80 g/m<sup>2</sup> or less.

[0041]

25 From a similar viewpoint, the thickness of the wiping sheet under a load of 40 N/m<sup>2</sup> is preferably 0.5 mm or more and more preferably 1.0 mm or more, and the upper limit under the same load is preferably 2.5 mm or less and more preferably 3 mm or less.

[0042]

The wiping sheet may be used without treatment of the fiber aggregate at the

time of wiping (in the form of what is called a dry sheet) or may be used in a form in which a cleaning liquid is applied to, sprayed to, supported in, or impregnated into the fiber aggregate (in the form of what is called a wet sheet). These forms may be selected depending on types of dust adhering to an object surface to be wiped or physical  
5 properties of an object to be wiped. From the viewpoint of improving the cleaning efficiency on an object surface to be cleaned, the fiber aggregate included in the wiping sheet preferably supports a cleaning liquid. In other words, the wiping sheet of the present invention is preferably in the form of a wet sheet. The fiber aggregate contains modified cross section fibers and thus has larger voids among the fibers. This  
10 advantageously improves the liquid retention performance of a cleaning liquid in the wiping sheet while improving the dust collection performance.

[0043]

When the wiping sheet is used in the form of a wet sheet at the time of wiping, a liquid having a typical composition used for a wet wiping sheet, such as water alone and  
15 an aqueous solution containing an additive, may be used as the cleaning liquid supported in the sheet. Examples of the additive used in the cleaning liquid include at least one selected from the group consisting of a surfactant, an antiseptic, a flavoring agent, a fragrance, a deodorant, a pH adjuster, an alcohol, abrasive particles, a gloss imparting agent, and a thickener.

20 [0044]

The wiping sheet of the present invention including the fiber aggregate containing the above modified cross section fibers is substantially a rectangular sheet having a longitudinal direction X and a width direction Y orthogonal to the longitudinal direction as shown in Fig. 4. From the viewpoint of effectively collecting particulate  
25 dust and fiber dust such as hair, a wiping sheet 1 preferably has, on at least one surface, an uneven portion with a macroscopic pattern having curved sections as shown in the figure and more preferably has an uneven portion with a macroscopic pattern having curved sections on a surface to be used as the wiping surface (the first surface 1F in Fig. 1).

[0045]

30 As shown in the figure, on one surface of the wiping sheet 1, pattern recessed

portions 3 and pattern projecting portions 4 included in the uneven portion with a macroscopic pattern are formed. The boundary between the pattern recessed portions 3 and the pattern projecting portions 4 has macroscopically curved portions. When the uneven portion with a macroscopic pattern is formed on one surface, the other surface  
5 does not have a complementary unevenness derived from the uneven portion with a macroscopic pattern but is flat.

[0046]

The uneven portion with a macroscopic pattern is not limited to the macroscopic pattern shown in the figure, and may, for example, be a macroscopic pattern shown in JP  
10 2017-113282 A or a macroscopic pattern in which shapes such as a straight line, a curved line, a circle, and a polygon are appropriately combined. The macroscopically curved portion means that a part of a side of a shape included in a pattern uneven portion can be visually identified as a curved line except the curved lines constituting microscale fine pores or the curved lines constituting drainage holes having a diameter of about 1.5 to 2  
15 mm. From such a viewpoint, the pattern recessed portions 3 and the pattern projecting portions 4 are preferably formed such that each pattern projecting portion 4 surrounded by the pattern recessed portions 3 has an area of 300 mm<sup>2</sup> or more. When having such an uneven portion with a macroscopic pattern, the wiping sheet itself advantageously has higher design properties.

20 [0047]

In the wiping sheet of the present invention, a single fiber aggregate may include a fiber aggregate in which the boundary in the sheet thickness direction between the first fiber region and the second fiber region is unclear or may include a fiber aggregate having a two-layer structure of a layer containing the first fibers and a layer containing the  
25 second fibers. Alternatively, the wiping sheet of the present invention may include a fiber aggregate having a multilayer structure including three or more layers of a layer containing the first fibers, a layer containing the second fibers, and layers containing other fibers.

[0048]

30 The wiping sheet of the present invention may consist of only a single fiber

aggregate containing modified cross section fibers (regardless of a single layer or a multilayer structure) or may have a multiply multilayer structure in which a first fiber aggregate containing the first and the second fibers is stacked on a second fiber aggregate regardless of whether or not modified cross section fibers are contained or on another sheet material except the fiber aggregate. Examples of the sheet material include a nonwoven fabric, a woven fabric, and paper.

[0049]

From the viewpoint of further improving the wiping sheet strength, the wiping sheet of the present invention may further include a scrim net for supporting a fiber aggregate included in the sheet. In the wiping sheet including a scrim net, the scrim net is preferably located in the center region of the fiber aggregate in the thickness direction. The scrim net can integrally be tangled with modified cross section fibers included in a fiber aggregate, and examples include a net-like scrim net, a grid-like scrim net, and a strand-like scrim net.

[0050]

The scrim net may be made from a resin. Examples of the resin include polyolefin resins such as polyethylene and polypropylene, polyester resins such as polyethylene terephthalate, polyamide resins such as nylon 6 and nylon 66, acrylonitrile resins such as polyacrylonitrile, vinyl resins such as polyvinyl chloride and polystyrene, and vinylidene resins such as polyvinylidene chloride.

[0051]

From the viewpoint of achieving both the tangling properties between constituent fibers and the scrim net and the wiping sheet strength, the wire diameter (the diameter in the lateral cross section) of the scrim net may be appropriately set depending on tangling degrees of fibers but is preferably 10  $\mu\text{m}$  or more and more preferably 500  $\mu\text{m}$  or more and is preferably 2,000  $\mu\text{m}$  or less and more preferably 1,000  $\mu\text{m}$  or less. The wire diameter of the scrim net may partially be different or may be the same. For a scrim net having partially different wire diameters, the wire diameter of the scrim is an average thereof. The basis weight of the scrim net is preferably 1  $\text{g/m}^2$  or more and more preferably 3  $\text{g/m}^2$  or more and is preferably 20  $\text{g/m}^2$  or less and more preferably 10  $\text{g/m}^2$

or less.

[0052]

Although an embodiment of the wiping sheet of the present invention has been described above, a preferred method for producing the wiping sheet will next be described with reference to Fig. 5. Fig. 5 shows a production apparatus 10 suitably used for production of the wiping sheet. The production apparatus 10 includes, in a conveyance direction (MD direction), a web forming unit 20, a first hydroentangling unit 30, and a second hydroentangling unit 40 in this order. The present production method includes a step of forming a fiber aggregate containing modified cross section fibers by hydroentanglement and may include a step of forming an uneven portion with a macroscopic pattern on one surface of the fiber aggregate, as needed. In the following description, the conveyance direction (MD direction) is coincident with the width direction Y of a sheet, and a direction orthogonal to the conveyance direction is coincident with the longitudinal direction X of a sheet.

15 [0053]

First, from a carding machine 21 in the web forming unit 20, a web of first fibers 11 is unreeled through a guide roll 22. For a wiping sheet including a scrim net, a scrim net 15 is unreeled from a scrim roll 25 together with the web of the first fibers 11. By the unreeling, the web of the first fibers 11 and the scrim net are stacked.

20 [0054]

Next, in the first hydroentangling unit 30, the web of the first fibers 11 (or the laminate of the web of the first fibers 11 and the scrim net 15) is hydroentangled by high-pressure water flows ejected from first water flow nozzles 31 while conveyed in the MD direction by a first support belt 32 through which water can pass (first entanglement step). Through the step, the first fibers 11 are entangled with each other to form an entangled body of the first fibers 11. For an embodiment including a scrim net, through the step, the first fibers 11 are entangled with each other, concurrently the first fibers 11 and the scrim net 15 are integrally tangled, and consequently an entangled body of the first fibers 11 with the scrim net is formed. In the step, the pressure of water sprayed from the first water flow nozzles 31 is preferably 30 kg/cm<sup>2</sup> or more and 80 kg/cm<sup>2</sup> or

less and more preferably  $40 \text{ kg/cm}^2$  or more and  $60 \text{ kg/cm}^2$  or less, and the conveyance speed of the web of the first fibers 11 in the MD direction is preferably 2 m/min or more and 10 m/min or less and more preferably 4 m/min or more and 8 m/min or less. The conditions enable the production.

5 [0055]

After the formation of the entangled body of the first fibers 11, an entangled body 12A of second fibers 12 are stacked thereon, and hydroentanglement is performed to give a fiber aggregate 1A (second entanglement step). Specifically, the entangled body of the first fibers 11 is conveyed in the MD direction, and on the top surface of the entangled body, a sheet-shaped entangled body 12A of second fibers 12 unreeled from an original fabric roll 41 is stacked to give a laminate 5. By spraying high-pressure water flows from second water flow nozzles 43 to the laminate 5, the constituent fibers of the respective entangled bodies are three-dimensionally entangled to form a fiber aggregate 1A. The pressure of water sprayed from the second water flow nozzles 43 and the conveyance speed of the laminate 5 may be in similar ranges to those in the above first entanglement step. In the fiber aggregate 1A formed in the step, the second fibers 12 are mainly present on the top surface, whereas the first fibers 11 (or the tangled body of the first fibers 11 and the scrim net 15) are mainly present on the bottom surface.

[0056]

20 After the second hydroentanglement step, the fiber aggregate 1A may be used as a wiping sheet 1 in the form of a dry sheet or a wet sheet, or as needed, an uneven portion with a macroscopic pattern may be formed on one surface of the fiber aggregate 1A as shown in Fig. 4 to give a wiping sheet 1 in the form of a dry sheet or a wet sheet.

[0057]

25 For example, for a wiping sheet in which an uneven portion with a macroscopic pattern is formed on the surface of the fiber aggregate 1A on which the second fibers 12 are mainly present (on the first surface 1F in Fig. 1), an uneven portion forming member 50 shown in Fig. 6 is placed on the surface of the fiber aggregate 1A on which the second fibers 12 are mainly present, then high-pressure water flows are sprayed to the surface opposite thereto (to the second surface 1R in Fig. 1), and consequently pattern recessed

portions 3 and pattern projecting portions 4 complementary to the uneven shape of the uneven portion forming member 50 can be formed on the first surface 1F of the fiber aggregate 1A. The pressure of water sprayed to the fiber aggregate 1A and the conveyance speed of the fiber aggregate may be in similar ranges to those in the above entanglement steps.

[0058]

The fiber aggregate 1A produced as above may be shaped, for example, into a rectangular shape as shown in Fig. 4, and then the resulting rectangular sheet may be used as a dry wiping sheet, or the fiber aggregate 1A may be allowed to support a cleaning liquid (supporting step) to be used as a wet wiping sheet. In the cleaning liquid supporting step, the support amount of a cleaning liquid supported in the fiber aggregate 1A is preferably 1 g/sheet or more and more preferably 10 g/sheet or more and is preferably 40 g/sheet or less and more preferably 25 g/sheet or less where the dimensions of the wiping sheet 1 are, for example, 285 mm × 205 mm as described in the following examples. In other words, the amount is preferably 17 g/m<sup>2</sup> or more and more preferably 117 g/m<sup>2</sup> or more and is preferably 690 g/m<sup>2</sup> or less and more preferably 430 g/m<sup>2</sup> or less.

[0059]

The wiping sheet produced as above may be used as the simple wiping sheet or be attached to a cleaning tool such as a wiper, for building such as floors and walls, fittings such as closets, windowpanes, mirrors, doors, and doorknobs, furniture such as rugs, carpets, and dining tables, a kitchen, a toilet, cleansing of human bodies, sanitary goods, packages, and the like.

[0060]

The present invention has been described on the basis of preferred embodiments thereof, but the present invention is not limited to the above embodiments. In order to form a fiber aggregate containing other fibers in addition to the first and the second fibers, for example, a second carding machine may be provided in the web forming unit 20, and an additional fiber web may be unreel from the carding machine and be stacked. The entanglement step is then performed, and consequently a fiber aggregate containing the

additional fibers together with the first fibers can be formed.

[0061]

In consideration of the above-described embodiments of the present invention, the following wiping sheets will be further disclosed.

5 <1>

A wiping sheet including a fiber aggregate at least containing first fibers and second fibers having a smaller diameter than that of the first fibers, these fibers being entangled in the fiber aggregate, the wiping sheet having a first surface and a second surface located opposite to the first surface,

10 in the wiping sheet, the second fibers are present at a higher proportion on the first surface than on the second surface, and

at least the first fibers are modified cross section fibers having a non-circular lateral cross section.

[0062]

15 <2>

The wiping sheet as set forth in clause <1>, in which the first fibers and the second fibers are the modified cross section fibers.

<3>

20 The wiping sheet as set forth in clause <1> or <2>, in which the modified cross section fibers have a lateral cross-sectional shape that is a convex polygonal shape or a regular polygonal shape such as a triangular shape, a quadrangular shape, a pentagonal shape, and a hexagonal shape.

<4>

25 The wiping sheet as set forth in any one of clauses <1> to <3>, in which the modified cross section fibers have a multilobal shape as the lateral cross-sectional shape.

<5>

The wiping sheet as set forth in any one of clauses <1> to <4>, consisting of the fiber aggregate alone.

<6>

30 The wiping sheet as set forth in any one of clauses <1> to <4>, further including an additional sheet material or an additional member in addition to the fiber aggregate.

[0063]

<7>

The wiping sheet as set forth in any one of clauses <1> to <6>, in which a proportion of the second fibers on the first surface in terms of area percentage is preferably 40% or more, more preferably 50% or more, and even more preferably 60% or more and is preferably 100% or less, more preferably 90% or less, and even more preferably 85% or less.

<8>

The wiping sheet as set forth in any one of clauses <1> to <7>, in which a proportion of the second fibers on the second surface in terms of area percentage is preferably 1% or more, more preferably 3% or more, and even more preferably 5% or more and is preferably 60% or less, more preferably 40% or less, and even more preferably 35% or less.

<9>

The wiping sheet as set forth in any one of clauses <1> to <8>, in which a proportion of the first fibers on the first surface in terms of area percentage is preferably 0% or more, more preferably 1% or more, and even more preferably 5% or more and is preferably 60% or less, more preferably 40% or less, and even more preferably 35% or less.

<10>

The wiping sheet as set forth in any one of clauses <1> to <9>, in which a proportion of the first fibers on the second surface in terms of area percentage is preferably 50% or more, more preferably 65% or more, and even more preferably 70% or more and is preferably 100% or less, more preferably 90% or less, and even more preferably 87% or less.

[0064]

<11>

The wiping sheet as set forth in any one of clauses <1> to <10>, in which constituent fibers in the fiber aggregate are not bonded to each other.

<12>

The wiping sheet as set forth in any one of clauses <1> to <11>, in which a cleaning liquid is supported in the fiber aggregate.

<13>

The wiping sheet as set forth in clause <12>, in which the cleaning liquid is an aqueous solution containing an additive.

<14>

5 The wiping sheet as set forth in clause <13>, in which the additive is at least one selected from the group consisting of a surfactant, an antiseptic, a flavoring agent, a fragrance, a deodorant, a pH adjuster, an alcohol, abrasive particles, a gloss imparting agent, and a thickener.

<15>

10 The wiping sheet as set forth in any one of clauses <1> to <14>, in which the first fibers are fibers including a thermoplastic resin.

[0065]

<16>

The wiping sheet as set forth in any one of clauses <1> to <15>, having a tensile elastic modulus of  $1.3 \times 10^{-3}$  N/mm<sup>2</sup> or more.

15 <17>

The wiping sheet as set forth in any one of clauses <1> to <16>, in which the tensile elastic modulus is preferably  $1.3 \times 10^{-3}$  N/mm<sup>2</sup> or more, more preferably  $1.4 \times 10^{-3}$  N/mm<sup>2</sup> or more, and even more preferably  $1.5 \times 10^{-3}$  N/mm<sup>2</sup> or more and is preferably  $5.0 \times 10^{-3}$  N/mm<sup>2</sup> or less.

20 <18>

The wiping sheet as set forth in any one of clauses <1> to <17>, in which a ratio of a fineness of the first fibers to a fineness of the second fibers is 10 or more and 2,000 or less.

<19>

25 The wiping sheet as set forth in any one of clauses <1> to <18>, in which the ratio of the fineness of the first fibers to the fineness of the second fibers is preferably 10 or more, more preferably 15 or more, and even more preferably 25 or more and is preferably 2,000 or less, more preferably 1,500 or less, and even more preferably 1,000 or less.

30 <20>

The wiping sheet as set forth in any one of clauses <1> to <19>, in which the fineness of the first fibers is preferably 0.5 dtex or more, more preferably 1 dtex or more, and even more preferably 1.2 dtex or more, and an upper limit thereof is preferably 3 dtex

or less, more preferably 2.5 dtex or less, and even more preferably 2 dtex or less.

[0066]

<21>

5 The wiping sheet as set forth in any one of clauses <1> to <20>, in which the first fibers and the second fibers are synthetic fibers.

<22>

The wiping sheet as set forth in any one of clauses <1> to <21>, having substantially a rectangular shape.

<23>

10 The wiping sheet as set forth in any one of clauses <1> to <22>, in which one surface of the wiping sheet has a pattern recessed portion and a pattern projecting portion that form an uneven portion with a macroscopic pattern, and a boundary between the pattern recessed portion and the pattern projecting portion macroscopically has a curved portion.

15 <24>

The wiping sheet as set forth in clause <23>, in which another surface of the wiping sheet having the uneven portion on the one surface is flat.

Examples

[0067]

20 The present invention will next be described in further detail with reference to examples. However, the scope of the present invention is not limited to the examples.

[0068]

[Example 1]

25 Modified cross section fibers made from a thermoplastic resin and having a multilobal shape as the fiber lateral cross-sectional shape (see Fig. 2(e)) were used as first fibers and subjected to hydroentanglement, giving a fiber aggregate. As for the constituent fibers in the fiber aggregate, multilobal fibers (made from PET, a fineness of 1.7 dtex, an average fiber diameter of 13.5  $\mu\text{m}$ ) were used as the first fibers, and perfect circular fibers (made from PP, a fineness of  $7.0 \times 10^{-3}$  dtex, an average fiber diameter of 1  $\mu\text{m}$ ) were used as the second fibers. As the fiber composition of the fiber aggregate, the

30

first fibers and the second fibers were contained at a mass ratio of 90:10. The fiber aggregate was shaped into dimensions of 285 mm × 205 mm, then a cleaning liquid was impregnated at 290 g/m<sup>2</sup>, and an intended wet wiping sheet was prepared. As the cleaning liquid, a 0.1% by mass aqueous solution of a surfactant (EMULGEN (registered trademark) 108, manufactured by Kao Corporation) was used. The wiping sheet had a basis weight of 67 g/m<sup>2</sup>.

[0069]

[Example 2]

The same procedure as in Example 1 was performed except that perfect circular fibers (made from PP, a fineness of  $1.7 \times 10^{-1}$  dtex, an average fiber diameter of 5.0 μm) different from the perfect circular fibers used in Example 1 were used as the second fibers, giving a wet wiping sheet. In other words, the wiping sheet of Example 2 contained multilobal fibers as the first fibers and perfect circular fibers as the second fibers.

[0070]

[Comparative Example 1]

Only fibers made from a thermoplastic resin and having a perfect circular shape as the fiber lateral cross-sectional shape were used as the first fibers and subjected to hydroentanglement, giving a fiber aggregate. The perfect circular fibers as the first fibers were made from PET and had a fineness of 1.45 dtex and an average fiber diameter of 11.5 μm. The same procedure as in Example 1 was performed except the above conditions, giving a wet wiping sheet. The wiping sheet of Comparative Example 1 contained no second fibers.

[0071]

[Comparative Example 2]

Only modified cross section fibers made from a thermoplastic resin and having a multilobal shape as the fiber lateral cross-sectional shape were used as the first fibers and subjected to hydroentanglement, giving a fiber aggregate. The multilobal fibers as the first fibers were made from PET and had a fineness of 1.7 dtex and an average fiber diameter of 13.5 μm. The same procedure as in Example 1 was performed except the

above conditions, giving a wet wiping sheet. The wiping sheet of Comparative Example 2 contained no second fibers.

[0072]

[Comparative Example 3]

5           Small diameter fibers made from a thermoplastic resin and having a perfect circular shape as the fiber lateral cross-sectional shape were used as the second fibers and subjected to hydroentanglement, giving a fiber aggregate. The perfect circular fibers as the second fibers were made from PP and had a fineness of  $7.0 \times 10^{-3}$  dtex and an average fiber diameter of 1  $\mu\text{m}$ . The same procedure as in Example 1 was performed except the  
10   above conditions, giving a wet wiping sheet. The wiping sheet of Comparative Example 3 contained no first fibers.

[0073]

[Comparative Example 4]

15           In Comparative Example 4, first and second fibers each having a perfect circular shape as the fiber lateral cross-sectional shape were used and subjected to hydroentanglement, giving a fiber aggregate in which the second fibers were present at a higher proportion on the first surface than on the second surface. As for the constituent fibers in the fiber aggregate, perfect circular fibers (made from PET, a fineness of 1.45 dtex, an average fiber diameter 11.5  $\mu\text{m}$ ) were used as the first fibers, and perfect circular  
20   fibers (made from PP, a fineness of  $7.0 \times 10^{-3}$  dtex, an average fiber diameter of about 1  $\mu\text{m}$ ) were used as the second fibers. As the fiber composition of the fiber aggregate, the first fibers and the second fibers were contained at a mass ratio of 90:10. The same procedure as in Example 1 was performed except the above conditions, giving a wet wiping sheet. In other words, in the wiping sheet of Comparative Example 4, the second  
25   fibers were mainly present on the first surface, and the first fibers were mainly present on the second surface. The proportion of the second fibers on the first surface (area percentage) was 73%, and the proportion of the second fibers on the second surface (area percentage) was 10%.

[0074]

30   [Evaluation of tensile elastic modulus]

The tensile elastic moduli of the wiping sheets of Examples and Comparative Examples were determined. Specifically, a tensile strength tester (manufactured by Shimadzu Corporation, AG-IS 100N) was used to stretch a dry sheet sample having a length of 150 mm and a width of 30 mm at a span of 100 mm and a speed of 300 mm/min in the longitudinal direction, and the tensile strength (N/mm) and the displacement (mm) were recorded. The tensile elastic modulus (N/mm<sup>2</sup>) was calculated by dividing a difference in tensile strength between 0 N/mm and 0.17 N/mm by a difference in displacement between these tensile strengths. A higher tensile elastic modulus indicates a higher sheet strength. The results are shown in Table 1.

10 [0075]

[Evaluation of particle collection performance]

In the evaluation, on a wood floor (DAG Floor, manufactured by Kitakei Co., Ltd.) having a length (cleansing direction) of 90 cm and a width of 90 cm, 0.1 g of 7 types of test powders (particle size: 5 to 75 μm) or 11 types of test particles (particle size: 1 to 8 μm) in accordance with JIS Z 8901 were sprinkled as a particulate dust model in an area having a length of 15 cm and a width of 90 cm in a range of 15 cm to 30 cm from the front in the cleansing direction. Each wiping sheet of Examples and Comparative Examples was used to wipe the wood floor while reciprocated twice in the cleansing direction for every area having a width of 30 cm. The operation was performed 6 times.

20 As for the sheet direction at the time of wiping, the width direction Y in Fig. 4 was coincident with the cleansing direction. The change in mass before and after the wiping was determined, and the particle collection performance was evaluated on the basis of the following criteria. The results are shown in Table 1.

[0076]

25 <Calculation formula>

Particulate dust collection efficiency (%) =  $100 \times ((\text{mass of wiping sheet after wiping [g]} - (\text{mass of wiping sheet before wiping [g]})) / 0.1 \text{ [g]})$

<Collection performance>

30 AA: The particulate dust collection efficiency is not less than 90%, and the particulate dust collection performance is very high.

A: The particulate dust collection efficiency is not less than 70% and less than 90%, and the particulate dust collection performance is high.

B: The particulate dust collection efficiency is not less than 50% and less than 70%, and the particulate dust collection performance is slightly low.

C: The particulate dust collection efficiency is less than 50%, and the particulate dust collection performance is low.

5 [0077]

[Evaluation of hair collection performance]

In the evaluation, a wood floor (DAG Floor, manufactured by Kitakei Co., Ltd.) having a 6-tatami mat size on which 20 pieces of hair having a length of 10 cm were sprinkled per single-tatami mat size (1,820 mm × 910 mm) was wiped. As for the sheet  
 10 direction at the time of wiping, the width direction Y in Fig. 4 was coincident with the cleansing direction. After the wiping, the number of pieces of hair collected by the wiping sheet was counted, and the hair collection performance was evaluated on the basis of the following criteria. The results are shown in Table 1.

[0078]

15 <Calculation formula>

Hair collection efficiency (%) =  $100 \times (\text{number of pieces of hair collected by wiping sheet [pieces]} / (\text{number of pieces of hair sprinkled [pieces]})$

<Collection performance>

20 AA: The hair collection efficiency is not less than 80%, and the hair collection performance is very high.

A: The hair collection efficiency is not less than 60% and less than 80%, and the hair collection performance is high.

B: The hair collection efficiency is not less than 40% and less than 60%, and the hair collection performance is slightly low.

25 C: The hair collection efficiency is less than 40%, and the hair collection performance is low.

[0079]

[Evaluation of sustained release performance of cleaning liquid]

Each wet wiping sheet of Examples and Comparative Examples was used under  
 30 a load of 0.16 kN/m<sup>2</sup> to continuously wipe a 20-tatami mat size (corresponding to 32.4

m<sup>2</sup>) of a wood floor (Combit New Advance 101, manufactured by WOOD ONE Co., Ltd.) as an intended surface to be wiped at a wiping speed of 1 m/s. From a liquid discharged amount (g) per single-tatami mat size, the discharged amount relative to the initial impregnation amount of the cleaning liquid was determined after cleaning of the area, and the sustained release performance of a cleaning liquid was evaluated on the basis of the following criteria. The results are shown in Table 1. A higher cleaning liquid discharge rate indicates a higher sustained release performance.

[0080]

<Evaluation>

AA: The cleaning liquid discharge rate after wiping of a 20-tatami mat area is not less than 70%.

A: The cleaning liquid discharge rate after wiping of a 20-tatami mat area is not less than 50% and less than 70%.

B: The cleaning liquid discharge rate after wiping of a 20-tatami mat area is not less than 30% and less than 50%.

C: The cleaning liquid discharge rate after wiping of a 20-tatami mat area is less than 30%.

[0081]

[Table 1]

|                       | First fibers [dtex] | Second fibers [dtex] | Tensile elastic modulus [N/mm <sup>2</sup> ] | Particle collection performance |                            | Hair collection performance | Sustained release performance of cleaning liquid |
|-----------------------|---------------------|----------------------|----------------------------------------------|---------------------------------|----------------------------|-----------------------------|--------------------------------------------------|
|                       |                     |                      |                                              | 7 types of test powders         | 11 types of test particles |                             |                                                  |
| Example 1             | 1.7                 | 7.0×10 <sup>-3</sup> | 1.67×10 <sup>-3</sup>                        | AA                              | A                          | AA                          | AA                                               |
| Example 2             | 1.7                 | 1.7×10 <sup>-1</sup> | 1.98×10 <sup>-3</sup>                        | AA                              | A                          | AA                          | A                                                |
| Comparative Example 1 | 1.45                | -                    | 1.03×10 <sup>-3</sup>                        | B                               | C                          | B                           | B                                                |
| Comparative Example 2 | 1.7                 | -                    | 1.27×10 <sup>-3</sup>                        | A                               | B                          | A                           | B                                                |
| Comparative Example 3 | -                   | 7.0×10 <sup>-3</sup> | 0                                            | A                               | B                          | B                           | A                                                |
| Comparative Example 4 | 1.45                | 7.0×10 <sup>-3</sup> | 1.16×10 <sup>-3</sup>                        | A                               | B                          | A                           | AA                                               |

[0082]

Table 1 reveals that the wiping sheet of the present invention contains, as the constituent fibers, modified cross section fibers and fibers having a smaller diameter than that of the modified cross section fibers, thus has high sheet strength, and has high collection performance for particulate dust and for fiber dust such as hair. The wiping sheet of the present invention in the form of a wet sheet is also revealed to have high sustained release performance of a cleaning liquid and to enable wiping in a wide area.

#### Industrial Applicability

[0083]

According to the present invention, a wiping sheet having both high strength and high dust collection performance can be provided.

## CLAIMS

1. A wiping sheet comprising:  
a fiber aggregate at least containing first fibers and second fibers having a smaller diameter than that of the first fibers, these fibers being entangled in the fiber aggregate,  
5 the wiping sheet having a first surface and a second surface located opposite to the first surface, wherein  
the second fibers are present at a higher proportion on the first surface than on the second surface, and  
10 at least the first fibers are modified cross section fibers having a non-circular lateral cross section.
2. The wiping sheet according to claim 1, wherein both the first fibers and the second fibers are the modified cross section fibers.
3. The wiping sheet according to claim 1 or 2, wherein the modified cross section  
15 fibers have a lateral cross-sectional shape that is a convex polygonal shape or a regular polygonal shape.
4. The wiping sheet according to any one of claims 1 to 3, wherein the modified cross section fibers have a multilobal shape as the lateral cross-sectional shape.
5. The wiping sheet according to any one of claims 1 to 4, consisting of the fiber  
20 aggregate alone.
6. The wiping sheet according to any one of claims 1 to 4, further comprising an additional sheet material or an additional member in addition to the fiber aggregate.
7. The wiping sheet according to any one of claims 1 to 6, wherein a proportion of  
the second fibers on the first surface in terms of area percentage is 40% or more and  
25 100% or less.

8. The wiping sheet according to any one of claims 1 to 7, wherein a proportion of the second fibers on the second surface in terms of area percentage is 1% or more and 60% or less.
9. The wiping sheet according to any one of claims 1 to 8, wherein a proportion of the first fibers on the first surface in terms of area percentage is 0% or more and 60% or less.
10. The wiping sheet according to any one of claims 1 to 9, wherein a proportion of the first fibers on the second surface in terms of area percentage is 50% or more and 100% or less.
11. The wiping sheet according to any one of claims 1 to 10, wherein constituent fibers in the fiber aggregate are not bonded to each other.
12. The wiping sheet according to any one of claims 1 to 11, wherein a cleaning liquid is supported in the fiber aggregate.
13. The wiping sheet according to claim 12, wherein the cleaning liquid is an aqueous solution containing an additive.
14. The wiping sheet according to claim 13, wherein the additive is at least one selected from the group consisting of a surfactant, an antiseptic, a flavoring agent, a fragrance, a deodorant, a pH adjuster, an alcohol, abrasive particles, a gloss imparting agent, and a thickener.
15. The wiping sheet according to any one of claims 1 to 14, wherein the first fibers are fibers including a thermoplastic resin.
16. The wiping sheet according to any one of claims 1 to 15, having a tensile elastic modulus of  $1.3 \times 10^{-3}$  N/mm<sup>2</sup> or more.

17. The wiping sheet according to any one of claims 1 to 16, having a tensile elastic modulus of  $1.3 \times 10^{-3} \text{ N/mm}^2$  or more and  $5.0 \times 10^{-3} \text{ N/mm}^2$  or less.
18. The wiping sheet according to any one of claims 1 to 17, wherein a ratio of a fineness of the first fibers to a fineness of the second fibers is 10 or more and 2,000 or less.
19. The wiping sheet according to any one of claims 1 to 18, wherein a ratio of a fineness of the first fibers to a fineness of the second fibers is 15 or more and 1,500 or less.
20. The wiping sheet according to any one of claims 1 to 19, wherein the first fibers have a fineness of 0.5 dtex or more and 3 dtex or less.
21. The wiping sheet according to any one of claims 1 to 20, wherein both the first fibers and the second fibers are synthetic fibers.
22. The wiping sheet according to any one of claims 1 to 21, wherein one surface of the wiping sheet has a pattern recessed portion and a pattern projecting portion that form an uneven portion with a macroscopic pattern, and a boundary between the pattern recessed portion and the pattern projecting portion macroscopically has a curved portion.
23. The wiping sheet according to claim 22, wherein another surface of the wiping sheet having the uneven portion on the one surface is flat.