

DESCRIPTION

CLEANING SHEET

Technical Field

[0001]

5 The present invention relates to a cleaning sheet that can suitably be used particularly for cleaning hard surfaces, for example.

Background Art

[0002]

 Various types of ball-shaped fiber aggregates are known in the art. For example,
10 Patent Literature 1 discloses a wadding consisting of ball-shaped wool fibers, wherein the wool fibers in the outer layer of the wadding have been felted. The ball-shaped wadding is made by: preparing a fiber strip by cutting a sliver consisting of opened wool fibers into a predetermined length; sandwiching the fiber strip between two opposing surfaces; rubbing the fiber strip by moving one or both of the surfaces; forming the fiber strip into a ball as well as
15 moistening the outer layer of the fiber strip; and fulling and felting the outer layer of the ball-shaped fiber strip.

[0003]

 Patent Literature 2 discloses a stuffed article used as bedclothes or clothes for cold weather. The stuffed article is made by: preparing stuffing balls consisting of main fibers
20 and binder fibers that have a softening point at least 20°C lower than that of the main fibers; blowing the stuffing balls into a covering cloth; and heat-treating the stuffing balls to integrate them together.

[0004]

 Patent Literature 3 discloses a ball-shaped fiber structure containing crimped
25 thermoplastic staple fibers and crimped heat-and-moisture bondable staple fibers. Some of the fibers that constitute the ball-shaped fiber structure are thermally bonded by the crimped heat-and-moisture bondable staple fibers. The ball-shaped fiber structure is made by:

spreading out, on a mesh, a mixture of staple fibers containing crimped thermoplastic staple fibers and crimped heat-and-moisture bondable staple fibers; rolling the staple fibers on the mesh while spraying misted water thereon, to form granular pieces of fiber therefrom; immersing the granular pieces into water; and causing the water in the water-impregnated granular pieces to boil and forming air bubbles therein, to thereby form a multitude of cell-like airspaces in the granular pieces; and at the same time, thermally bonding some of the fibers that constitute the granular pieces by means of the crimped heat-and-moisture bondable staple fibers.

[0005]

None of the above-mentioned Patent Literatures, however, describe using the ball-shaped fiber aggregates disclosed therein as materials for a cleaning sheet.

[0006]

Meanwhile, cleaning sheets having fiber aggregates, although not ball-shaped, are known in the art. For example, Patent Literature 4 discloses such a cleaning sheet. The cleaning sheet disclosed therein is composed of a heat-sealable sheet and a multitude of heat-sealable continuous filaments joined to the sheet and extending in one direction. The continuous filaments are joined to the heat-sealable sheet by a plurality of heat-seal lines that extend in a direction crossing the continuous filaments and that are arranged intermittently with respect to the length direction of the continuous filaments. With this cleaning sheet, dirt is trapped among the continuous filaments. The continuous filaments, however, are fixed at their front and rear portions by the heat-seal lines, and are thus limited in terms of degree of freedom in movement, resulting in insufficient trapping of dirt among the fibers. Also, the heat-seal lines themselves cannot trap dirt, thus making the dirt trapping efficiency unsatisfactory.

[0007]

Patent Literature 5 discloses a cleaning sheet similar to the one disclosed in Patent Literature 4. The cleaning sheet disclosed in Patent Literature 5 forms a cleaning section by

joining, to a base sheet, a fiber bundle made by bundling together a multitude of fibers. Patent Literature 5 describes that the cleaning sheet can sufficiently wipe off dirt of a fairly large size. The fibers in the cleaning sheet, however, are oriented in a single direction, and thus, depending on the wiping direction, there are instances where dirt cannot be trapped
5 securely.

[0008]

Patent Literature 1: JP-A-58-70758

Patent Literature 2: JP-A-61-125377

Patent Literature 3: JP-A-2002-212868

10 Patent Literature 4: US 6,329,308 B1

Patent Literature 5: JP-A-2007-289341

Disclosure of Invention

[0009]

The present invention provides a substrate sheet and a cleaning sheet including a
15 plurality of clump-like fiber aggregate bundles joined to at least one side of the substrate sheet to form a cleaning section. Each of the clump-like fiber aggregate bundles is formed by joining together, at a joining section, a plurality of fibers that have been arranged in one direction and opening those fibers extending from the joining section.

[0010]

20 The present invention also provides a preferable method for manufacturing the above-mentioned cleaning sheet. The method of manufacturing a cleaning sheet includes:

forming a continuous-filament bundle by joining together a plurality of continuous filaments that have been arranged in one direction with a plurality of joining sections that extend in a direction intersecting with the direction in which the continuous filaments are
25 arranged;

forming unopened staple-fiber bundles by cutting the continuous-filament bundle between adjacent joining sections;

forming a clump-like fiber aggregate bundle by blowing a fluid on the unopened staple-fiber bundle to open the fibers extending from the joining section; and

joining a plurality of the clump-like fiber aggregate bundles to at least one side of a substrate sheet.

5 [0011]

The present invention also provides another preferable method for manufacturing the above-mentioned cleaning sheet. The method of manufacturing a cleaning sheet includes:

forming a continuous-filament bundle by joining together a plurality of continuous filaments that have been arranged in one direction with a plurality of joining sections that
10 extend in a direction intersecting with the direction in which the continuous filaments are arranged;

forming unopened staple-fiber bundles by cutting the continuous-filament bundle between adjacent joining sections;

joining a plurality of the unopened staple-fiber bundles to at least one side of a substrate
15 sheet; and

forming clump-like fiber aggregate bundles fixed to the substrate sheet by blowing a fluid on the unopened staple-fiber bundles to open the fibers extending from the joining section.

Brief Description of Drawings

20 [0012]

[Fig. 1] Fig. 1 is a perspective illustrating a first embodiment of a cleaning sheet of the present invention.

[Fig. 2] Fig. 2 is a cross-sectional view taken along line II-II in Fig. 1.

[Fig. 3] Fig. 3 illustrates perspectives of an unopened staple-fiber bundle and a
25 clump-like fiber aggregate bundle.

[Fig. 4] Fig. 4 is a perspective illustrating one way of using the cleaning sheet illustrated in Fig. 1.

[Fig. 5] Fig. 5 is a schematic diagram illustrating a device for manufacturing an unopened staple-fiber bundle.

[Fig. 6] Fig. 6(a) to Fig. 6(d) are schematic diagrams sequentially illustrating the processes of manufacturing an unopened staple-fiber bundle.

5 [Fig. 7] Fig. 7(a) is a schematic diagram illustrating another device for manufacturing an unopened staple-fiber bundle; and Fig. 7(b) is a schematic diagram illustrating one of the processes of manufacturing an unopened staple-fiber bundle using the manufacturing device illustrated in Fig. 7(a).

10 [Fig. 8] Fig. 8(a) and Fig. 8(b) are schematic diagrams illustrating a device for opening an unopened staple-fiber bundle.

[Fig. 9] Fig. 9 is a schematic diagram illustrating a device for manufacturing a cleaning sheet.

[Fig. 10] Fig. 10 is a schematic diagram illustrating another device for manufacturing a cleaning sheet.

15 [Fig. 11] Fig. 11 is a perspective (corresponding to Fig. 1) illustrating a second embodiment of a cleaning sheet of the present invention.

[Fig. 12] Fig. 12 is a perspective (corresponding to Fig. 1) illustrating a third embodiment of a cleaning sheet of the present invention.

20 [Fig. 13] Fig. 13 is a perspective (corresponding to Fig. 1) illustrating a fourth embodiment of a cleaning sheet of the present invention.

[Fig. 14] Fig. 14 is a perspective illustrating a fifth embodiment of a cleaning sheet of the present invention.

[Fig. 15] Fig. 15 is a schematic diagram illustrating a device for manufacturing the cleaning sheet illustrated in Fig. 14.

25 [Fig. 16] Fig. 16 is a perspective (corresponding to Fig. 14) illustrating a sixth embodiment of a cleaning sheet of the present invention.

[Fig. 17] Fig. 17 is a perspective (corresponding to Fig. 14) illustrating a seventh

embodiment of a cleaning sheet of the present invention.

[Fig. 18] Fig. 18 is a perspective (corresponding to Fig. 14) illustrating an eighth embodiment of a cleaning sheet of the present invention.

Best Mode for carrying out the Invention

5 [0013]

The present invention will be described below according to preferred embodiments thereof with reference to the drawings. Fig. 1 illustrates a perspective of a first embodiment of a cleaning sheet according to the present invention. Fig. 2 is a cross-sectional view taken along line II-II in Fig. 1. The cleaning sheet 10 of the present embodiment includes a
10 substrate sheet 11. The substrate sheet 11 is rectangular, having a length direction X and a width direction Y orthogonal thereto. The cleaning sheet 10 has a cleaning section 12 on one side of the substrate sheet. The cleaning section 12 is substantially rectangular as viewed from above, having a length direction X and a width direction Y. The cleaning section 12 is located in a central area of the substrate sheet 11 with respect to the width direction Y. The
15 substrate sheet 11 has a pair of flaps 11a extending sideward from the left and right side edges 12a of the cleaning section 12. With respect to the length direction X, on the other hand, the cleaning section 12 spans the entire area of the substrate sheet 11 in the length direction X. The cleaning section 12 consists of fiber aggregates and is formed to have a predetermined thickness.

20 [0014]

The fiber aggregates that constitute the cleaning section 12 consist of fiber aggregate bundles in a clump-like form (e.g., substantially ball-shaped or shaped like *Aegagropila linnaei*). The clump-like fiber aggregate bundle will be described below. A clump-like fiber aggregate bundle is produced from an unopened staple-fiber bundle 20' illustrated in Fig.
25 3. The unopened staple-fiber bundle 20' is formed by joining together a plurality of fibers 21 that have been arranged in one direction with a joining section 22 that extends in a direction intersecting with the direction in which the fibers 21 are arranged. There is only one joining

section 22 formed therein. The fibers 21 extending from the joining section 22 in the unopened staple-fiber bundle 20' are opened to assume a clump-like shape (e.g., substantially ball-shape or a shape like *Aegagropila linnaei*), which is the clump-like fiber aggregate bundle 20 as illustrated in Fig. 3. The process according to which the fibers 21 are opened will be described further below.

[0015]

The unopened staple-fiber bundle 20' illustrated in Fig. 3 is flat, but the shape of the unopened staple-fiber bundle 20' is not limited thereto and may be, for example, cylindrical, prism-shaped, or twisted (helical).

[0016]

The clump-like fiber aggregate bundle 20 illustrated in Fig. 3 has a joining section 22 (although not illustrated) substantially in its center. The fibers 21 extending from the joining section 22 (not illustrated) are opened radially to form a bundle of fibers having a clump-like form (e.g., substantially ball-shaped or shaped like *Aegagropila linnaei*), which is the clump-like fiber aggregate bundle 20.

[0017]

Each fiber 21 constituting the clump-like fiber aggregate bundle 20 is preferably 3 to 150 mm long, and more preferably 5 to 50 mm long. Setting the fiber length within this range allows the fibers 21 to be opened favorably and thus allows the fibers to trap dirt therebetween securely. In cases where the fibers 21 are crimped as described further below, the length measured in a state where the crimps have been straightened out is regarded as the "length of the fiber 21".

[0018]

The joining section 22 is formed substantially in the lengthwise central area of the fibers 21 constituting the clump-like fiber aggregate bundle 20. The joining section 22 is formed, for example, by melting and hardening of the fibers 21. Alternatively, the joining section 22 may be formed through bonding using a bonding agent. The joining section 22

has a predetermined width d and extends in a direction orthogonal to the direction of arrangement of the constituent fibers 21, which are arranged in one direction. Although the width d of the joining section 22 depends on, for example, the length and material of the fibers 21 and how the joining section 22 is formed, a width of 0.5 to 80 mm, and more preferably 1 to 40 mm, will allow the fibers 21 to be joined together securely.

[0019]

Although the number of fibers 21 included in a single clump-like fiber aggregate bundle 20 depends on the thickness of the fibers 21, the number is preferably 100 to 100,000, and more preferably 1000 to 50,000. Setting the number of fibers 21 within this range allows the density of the opened fibers to take a value suitable for trapping dirt. For the same reason, the total fineness (thickness) of the clump-like fiber aggregate bundle 20 as a whole is preferably 1 to 8000 tex, and more preferably 10 to 4000 tex.

[0020]

The thickness of each fiber 21 is preferably 0.05 to 80 dtex, and more preferably 0.5 to 40 dtex. Setting the thickness within this range provides the fibers 21 with suitable rigidity and allows the cleaning section 12 to sufficiently conform to uneven surfaces to be cleaned, such as a sill or a rail of a sliding door. Further, the cleaning section 12 will be able to sufficiently conform to narrow spaces, such as corners of a room or a doorstep and its surroundings. Furthermore, the dirt trapping capabilities will improve.

[0021]

Crimped fibers may preferably be used for the fibers 21 to further improve their dirt trapping capabilities. Two-dimensionally or three-dimensionally crimped fibers can be used. It is preferable that the crimped fiber has a percentage of crimp (JIS L0208) of 5 to 50%, and more preferably 10 to 30%. The percentage of crimp is defined as a percentage of a difference between the length A of a crimped fiber in its straightened state and the natural length B of the crimped fiber with respect to the length A , and is calculated by the following equation:

$$\text{Percentage of crimp (\%)} = (A - B)/A \times 100$$

[0022]

The number of crimps and the height of crimp of the crimped fibers are related to the bulkiness of the clump-like fiber aggregate bundle 20. More specifically, the clump-like fiber aggregate bundle 20 becomes more bulky as the number of crimps and the height of crimp are increased. From this standpoint, the number of crimps is preferably 3 to 80, and more preferably 5 to 40. The height of crimp is preferably 0.1 to 8.0 mm, and more preferably 0.2 to 4.0 mm.

[0023]

The above-mentioned number of crimps is measured according to JIS L1015. The height of crimp is measured as follows. Observing the fibers 21, three or more sections that have the strongest (highest) crimps and that are not adjacent to one another are located. Then, an aggregate of fibers 21 (and not just a single piece of fiber 21) having substantially the same curved form is located in each of the sections, and each aggregate is cut out so as not to break its form. A cardboard or the like is laid down and fixed in a horizontal state, and the cut-out fibers 21 are fixed at one longitudinal end thereof to the cardboard with a transparent tape in such a manner as not to place any load on the fibers other than their own weights and not to warp the cardboard etc. In cases where the fibers 21 include two-dimensional or three-dimensional crimps, the fibers 21 are fixed so that the difference in the peaks and troughs thereof appears most significantly. The fibers 21 are photographed in a linear-as-possible state without the fibers rising up from the cardboard etc. A scale or the like is taken in the same photograph to allow confirmation of the actual size. The photograph is enlarged (preferably four or more times) with a device allowing enlargement such as a copier or a scanner, so that the fibers 21 are clearly visible. Of the enlarged fibers 21, a linear section having good crimping regularity is selected, and the vertical direction is determined with reference to an area in which the fibers 21 are less irregular or appear more clearly. Then, the vertices of the adjacent troughs are connected, while paying attention to

the inner and outer sides of the aggregate of fibers 21. Then, the substantially-perpendicular distance from each of five consecutive peaks to the above-mentioned line connecting the adjacent troughs is measured. Here, the actual dimension is measured and determined for each of the five peaks while paying attention to magnification etc., and the average thereof is taken as the measurement value for this certain section. The other sections cut out from the same sample are measured in the same way. The three largest measurement values of all of the sections in the sample are averaged, and this average is taken as the height of crimp of that certain sample.

[0024]

10 The size of the clump-like fiber aggregate bundle 20 (before being joined to a substrate sheet 11) is preferably 0.2 to 1000 cm³, and more preferably 0.5 to 125 cm³, in volume.

[0025]

In the cleaning sheet 10, a cleaning section 12 is formed thereon by joining the clump-like fiber aggregate bundles 20 to one side of the substrate sheet 11, without leaving any space between the clump-like fiber aggregate bundles 20. Accordingly, the clump-like fiber aggregate bundles 20, when joined to the substrate sheet 11, assume a flat shape having a certain thickness, even though each clump-like fiber aggregate bundle 20 is, for example, ball-shaped before being joined. The above-mentioned thickness corresponds to the thickness of the cleaning section 12. The clump-like fiber aggregate bundles 20 may be arranged in a single layer or may be arranged in two or more layers. In either case, the clump-like fiber aggregate bundles 20 are arranged such that the cleaning section 12 has a substantially even thickness in all areas.

[0026]

As illustrated in Fig. 1, the substrate sheet 11 and the clump-like fiber aggregate bundles 20 are joined at joining points 13. The joining points are formed, for example, through fusion-bonding between the substrate sheet 11 and the fibers 21 constituting the clump-like fiber aggregate bundles 20. Alternatively, the joining points may be formed

through bonding of the substrate sheet 11 and the fibers 21. The joining points 13 may be arranged regularly or randomly. According to the manufacturing method described further below, the joining points 13 will be arranged regularly.

[0027]

5 The clump-like fiber aggregate bundles 20 do not have to be joined to the substrate sheet 11 at the positions of the joining sections 22. In other words, the joining point 13 does not have to be formed at the position of the joining section 22. The clump-like fiber aggregate bundles 20 may be joined to the substrate sheet 11 at any position thereon as long as the clump-like fiber aggregate bundles 20 are securely joined to the substrate sheet 11 and do
10 not fall off therefrom.

[0028]

Although the total basis weight of the clump-like fiber aggregate bundle 20 constituting the cleaning section 12 depends on the total fineness of the clump-like fiber aggregate bundle 20 and the length of the fiber 21, it is preferable that the total basis weight is 10 to 1000 g/m²,
15 and more preferably 50 to 500 g/m², from the standpoint of allowing the cleaning sheet 10 to conform favorably to uneven surfaces to be cleaned and from the standpoint of providing voluminosity and a comfortable wiping feeling to the cleaning sheet 10. In relation to the above, it is preferable that the thickness of the cleaning sheet 10 in the cleaning section 12 is 1 to 100 mm, and more preferably 2 to 50 mm, under a load of 300 Pa.

20 [0029]

In the cleaning section 12, the fibers 21 constituting the clump-like fiber aggregate bundles 20 are oriented mainly in the planar direction of the cleaning section 12. The fibers 21 oriented in the planar direction do not all extend in the same direction, but are oriented in all directions within the plane. Furthermore, many of the fibers 21 are also oriented in the
25 thickness direction of the cleaning section 12. Additionally, one of the opposite ends of each fiber 21 is a free end, thus providing an extremely high degree of freedom in movement. Because the fibers 21 in the cleaning section 12 are oriented in various directions and the

degree of freedom in movement thereof is extremely high, dirt can be caught among the fibers 21, regardless of the wiping direction of the cleaning sheet 10. In contrast, in the cleaning sheets disclosed in Patent Literatures 4 and 5 described in the Background Art, for example, all the fibers are oriented in a single direction. Therefore, even though dirt can be trapped
5 among the fibers when wiping is performed in a direction intersecting with the fiber-orientation direction, the dirt trapping efficiency drops significantly when wiping is performed along the fiber-orientation direction. Further, in the cleaning sheet disclosed in Patent Literature 4, both ends of the fiber are fixed, which means that the degree of freedom of fiber movement is low and the dirt trapping efficiency cannot be improved easily.

10 [0030]

For the fibers 21, it is possible to use, for example, synthetic fibers such as thermoplastic resins, natural fibers such as cotton or hemp, recycled fibers such as rayon, or semi-synthetic fibers such as acetate. These fibers may be used singly, or two or more may be used in combination. Considering the ease of forming the joining section 22 in the
15 unopened staple-fiber bundle 20' (see Fig. 3) and the ease of joining the clump-like fiber aggregate bundles 20 to the substrate sheet 11, it is preferable to use, for the fibers 21, a synthetic fiber made of a thermoplastic resin which is a material allowing easy heat-fusion bonding. Examples of thermoplastic resins that may be used include polyolefin-based resins such as polyethylene and polypropylene, polyester-based resins such as polyethylene
20 terephthalate, acrylic resins, and vinyl resins. The synthetic fiber may consist of a single type of resin, or may be a conjugate fiber (such as a sheath/core conjugate fiber or a side-by-side conjugate fiber) including two or more types of resins in combination.

[0031]

The fibers 21 may have a chemical agent applied thereto. Applying a chemical agent
25 for use in dry-type cleaning purposes will improve trapping capabilities through utilization of adsorption of dirt. Examples of such a chemical agent include various oil-solution components. Examples of oil-solution components that may be used include oil solutions

such as mineral oils, synthetic oils, and silicone oil, and mixtures containing the above-mentioned oil-solution component(s) and agents such as surfactants, solvents, antioxidants, and perfumes. The amount of chemical agent, such as the oil-solution component, to be applied may range from around 0.1 to 50% by weight with respect to the weight of the fibers 21.

[0032]

In cases where the cleaning sheet 10 of the present embodiment is to be used for wet cleaning purposes, impregnating the sheet with a cleaning agent will allow stains and/or caked-on solid crud to dissolve and thus improve cleaning capabilities. Usable cleaning agents may include a mixture containing surfactants, solvents, antimicrobial agents, antiseptics, perfumes, water, etc. The amount of cleaning agent to be impregnated may range from around 20 to 500% by weight with respect to the weight of the fibers 21.

[0033]

In addition to being used for dry-type and wet cleaning purposes, the cleaning sheet 10 of the present embodiment can also be used like a dustcloth or floorcloth--i.e., it may be used to spread, wipe off, or be impregnated with, liquids such as water, commercially-available cleaning agents, or wax.

[0034]

From the standpoint of allowing easy joining of the clump-like fiber aggregate bundles 20, it is possible to use, for the substrate sheet 11 to which the clump-like fiber aggregate bundles 20 are fixed, various nonwoven fabrics made of synthetic resin, films, paper/paperboard made from pulp, paper/paperboard made by blending synthetic resin in pulp, or composite materials of the above. Suitable examples of usable nonwoven fabrics include air-through nonwovens, spun-bonded nonwovens, and air-laid nonwovens. From the standpoint of strength, firmness, and the like, it is preferable that the basis weight of the nonwoven fabric be 3 to 200 g/m², and more preferably 10 to 100 g/m². Also, in cases where films are used, it is preferable that the basis weight thereof be 3 to 500 g/m², and more

preferably 10 to 250 g/m², for the above-mentioned reason. In cases where paper/paperboard is used, the basis weight thereof is preferably 10 to 500 g/m², and more preferably 20 to 250 g/m². Examples of synthetic resins usable for the substrate sheet 11 include the same resins mentioned above as the synthetic resins constituting the fibers 21.

5 [0035]

As illustrated for example in Fig. 4, the cleaning sheet 10 is used by being attached to a cleaning tool 100. The cleaning tool 100 has a head 101 to which the cleaning sheet 10 can be attached, and a rod-like handle 102 connected to the head 101 via a universal joint 103. The attachment surface (bottom surface) of the head 101 is rectangular as viewed from above.

10 Normally, the cleaning tool 100 is used to perform cleaning by moving (particularly back and forth) the head 101 along its width direction. The cleaning sheet 10 is attached to the head 101 of the cleaning tool 100, which includes the head 101 and the handle 102 connected to the head 101, by utilizing the substrate sheet 11. The cleaning sheet 10 is attached to the head 101 so that the side of the substrate sheet 11 without the cleaning section 12 faces the

15 attachment surface (bottom surface) of the head 101. Then, the flaps 11a of the substrate sheet 11 are folded back toward the upper surface of the head 101. The flaps 11a are then pressed into a plurality of flexible sheet retainers 104 provided in the head 101, each having slits in a radial pattern. In this way, the cleaning sheet 10 can be fixed to the head 101 of the cleaning tool 100 utilizing the flaps 11a of the substrate sheet 11. Note that it is preferable

20 that the substrate sheet 11 includes a net (scrim) as in the embodiments illustrated in Figs. 11 and 12 further below, because of the good engagement between the substrate sheet 11 and the sheet retainers 104. The cleaning sheet 10 of the present embodiment can be used in this state for wiping hard surfaces, such as wooden floors, walls, ceilings, glass panes, mirrors, furniture, home electrical appliances, outer walls of houses, and car bodies.

25 [0036]

Next, a preferred method for manufacturing the cleaning sheet 10 of the present embodiment is described with reference to Figs. 5 to 9. The present manufacturing method

is roughly divided into: (A) a step of manufacturing clump-like fiber aggregate bundles 20; and (B) a step of joining the clump-like fiber aggregate bundles 20 to a substrate sheet 11.

The step (A) of manufacturing clump-like fiber aggregate bundles 20 is roughly divided into:

(A-1) a step of manufacturing a continuous-filament bundle; (A-2) a step of manufacturing

5 unopened staple-fiber bundles; and (A-3) a step of manufacturing clump-like fiber aggregate bundles.

[0037]

In step (A-1) of manufacturing a continuous-filament bundle, a continuous-filament bundle is formed by joining together a plurality of continuous filaments that have been
10 arranged in one direction with a plurality of joining sections that extend in a direction intersecting with the direction in which the continuous filaments are arranged. In step (A-2) of manufacturing unopened staple-fiber bundles, unopened staple-fiber bundles are formed by cutting the continuous-filament bundle between adjacent joining sections. In step (A-3) of manufacturing clump-like fiber aggregate bundles, clump-like fiber aggregate bundles are
15 formed by blowing a fluid on the unopened staple-fiber bundles to open the fibers extending from the joining sections.

[0038]

First, step (A) of manufacturing clump-like fiber aggregate bundles 20 is described with reference to Figs. 5 to 8. Fig. 5 schematically illustrates a device 30 for manufacturing
20 continuous-filament bundles and unopened staple-fiber bundles. First, a bundle 23 of continuous filaments, which are the starting materials, is paid out from a feeder 31. The bundle 23 of continuous filaments consists of a plurality of continuous filaments drawn and lined up in a single direction and bundled together. These continuous filaments become the fibers 21 constituting the intended clump-like fiber aggregate bundle 20. The number of
25 continuous filaments in the bundle 23 of continuous filaments is equal to or larger than the number of fibers 21 in the intended clump-like fiber aggregate bundle 20.

[0039]

The paid-out bundle 23 of continuous filaments is sent into an opening device 32, where it is widened in width in a direction orthogonal to the carrying direction and made into an opened tow 24. This state is illustrated in Fig. 6(a). Note that in Fig. 6(a), the direction from left to right of the paper face is the carrying direction, and the same applies to Fig. 6(b) to Fig. 6(d). The opening device 3 includes a plurality of pairs of blooming rolls 33, 34 (three pairs in Fig. 3) arranged along the carrying direction of the bundle 23 of continuous filaments. Each pair of blooming rolls 33, 34 consists of a metal grooved roll 33 having a multitude of circumferentially-extending grooves and ridges arranged alternately in the roll's axial direction and an anvil roll 34 that opposes and comes into contact with the grooved roll 33 and whose circumferential surface is made of rubber. Blooming rolls 33, 34 having such a structure are known in the art. By being passed between the grooved rolls 33 and the anvil rolls 34, the bundle 23 of continuous filaments is widened in its width and made into an opened tow 24.

[0040]

The opened tow 24 made by the opening device 32 is sent into a chemical agent applying device 35. The chemical agent applying device 35 applies a chemical agent to the opened tow 24 from the upper and lower surfaces thereof. Here, the above-mentioned chemical agent is used. The chemical agent is applied, for example, using a spraying device. Alternatively, gravure roll coating may be used for applying the chemical agent.

[0041]

The chemical-agent-applied opened tow 24 is then sent into a joining device 36. The joining device 36 includes a pair of embossing rolls 36a, 36b. Each embossing roll 36a or 36b has axially-extending linear ridges 36c arranged at predetermined intervals in the roll's circumferential direction. The embossing rolls 36a, 36b are heatable. During rotation, the ridges 36c on one embossing roll 36a oppose and come into contact with the ridges 36c on the other embossing roll 36b. As the opened tow 24 passes between the rolls, the continuous filaments constituting the opened tow 24 are molten and hardened by the effect of heat and

pressure, thereby forming on the opened tow 24 a plurality of joining sections 22' which extend in a direction intersecting with the direction in which the constituent continuous filaments extend. This state is illustrated in Fig. 6(b). As illustrated in Fig. 6(b), the joining sections 22' extend in a direction orthogonal to the direction in which the continuous filaments constituting the opened tow 24 extend. The joining sections 22' in Fig. 6(b) are illustrated as straight lines that extend in a direction orthogonal to the direction in which the continuous filaments constituting the opened tow 24 extend, but they may instead be straight lines extending in an oblique direction, or they may be curved lines. The distances between adjacent joining sections 22' are constant. Forming these joining sections 22' joins the continuous filaments together. The joining section 22' corresponds to the joining section 22 in the above-mentioned unopened staple-fiber bundle illustrated in Fig. 2.

[0042]

The opened tow 24 having the plurality of joining sections 22' is then sent into a slit 37. The slit 37 includes a first roll 37a having a plurality of circular blades arranged at predetermined intervals in the roll's axial direction, and an anvil roll 37b. By being sent into the slit 37, the opened tow 24 is cut along the extending direction of the continuous filaments and at predetermined intervals in the width direction. Accordingly, the opened tow 24 is cut into a plurality of pieces with respect to the width direction of the tow 24, thus forming a plurality of continuous-filament bundles 25, as illustrated in Fig. 6(c).

[0043]

As illustrated in Fig. 5, each continuous-filament bundle 25 is sent into a widthwise cutting device 38. The widthwise cutting device 38 includes a first roll 38a in which ridge-like blades 38c extending in the roll's axial direction are arranged at predetermined intervals in the roll's circumferential direction, and an anvil roll 38b opposing the first roll 38a. The rolls 38a, 38b are arranged at such a distance that the ridge-like blades 38c on the first roll 38a either contact or come close to the circumferential surface of the anvil roll 38b. Sending each continuous-filament bundle 25 between the rolls of the widthwise cutting device 38 will

cut each continuous-filament bundle 25 along the width direction as illustrated in Fig. 6(d) at positions between adjacent joining sections 22' (positions illustrated by alternate long-and-short dashed lines in the figure). Through this cutting step, the intended unopened staple-fiber bundles 20' are formed.

5 [0044]

The steps described above are for manufacturing unopened staple-fiber bundles 20' from the bundle 23 of continuous filaments, which is the starting material. However, the unopened staple-fiber bundles 20' can be manufactured according to a different procedure. An alternative manufacturing method is described with reference to Fig. 7(a) and Fig. 7(b).
10 In this manufacturing method, the steps up to forming an opened tow 24 from a bundle 23 of continuous filaments serving as the starting material and applying an oil solution thereto are the same as those in the manufacturing method illustrated in Figs. 5 and 6. The oil-solution-applied opened tow 24 is then sent into a dividing device 39, where it is divided into a plurality of pieces along the extending direction of the continuous filaments and at
15 predetermined intervals in the width direction, thus forming a plurality of divided opened tows 26. This state is illustrated in Fig. 7(b). The dividing device 39 includes a plurality of pairs of blooming rolls 39a, 39b (three pairs in Fig. 7(a)) arranged along the carrying direction of the opened tow 24. Each pair of blooming rolls 39a, 39b consist of a metal grooved roll 39a having a multitude of circumferentially-extending grooves and ridges arranged alternately
20 in the roll's axial direction and an anvil roll 39b that opposes and comes into contact with the grooved roll 39a and whose circumferential surface is made of rubber. The grooves provided in the grooved roll 39a are arranged in such a manner that the opened tow 24 can be divided into a plurality of pieces with respect to the width direction. The number of continuous filaments in each divided opened tow 26 formed by the dividing device 39 will be
25 equal to the number of fibers 21 in the intended unopened staple-fiber bundle 20'.

[0045]

Each divided opened tow 26 is then sent into a joining device 36. The joining device

36 is the same as the one illustrated in Fig. 5. By the effect of heat and pressure using the joining device 36, the continuous filaments constituting the divided opened tow 26 are molten and hardened, thereby forming on the divided opened tow 26 a plurality of joining sections 22' which extend in a direction intersecting with the direction in which the constituent continuous filaments extend. This state is the same as that illustrated in Fig. 6(c). In this way, a plurality of continuous-filament bundles 25 are formed. Each continuous-filament bundle 25 is then sent into a widthwise cutting device 38. The widthwise cutting device 38 is the same as that illustrated in Fig. 5. The widthwise cutting device 38 cuts each continuous-filament bundle 25 along the width direction at positions between adjacent joining sections 22'. This state is the same as that illustrated in Fig. 6(d). Through this cutting step, the intended unopened staple-fiber bundles 20' are formed.

[0046]

The unopened staple-fiber bundles 20' manufactured using either the device illustrated in Fig. 5 or the device illustrated in Fig. 7 then undergo an opening step. The opening step is described in detail with reference to Fig. 8(a) and Fig. 8(b). As illustrated in Fig. 8(a), the unopened staple-fiber bundles 20' are placed inside a hermetically-sealed hollow chamber 40. The chamber 40 has an introduction portion 40 for introducing a fluid into the chamber 40, and a discharge portion 42 for discharging the fluid introduced in the chamber 40 to the outside.

[0047]

When a fluid is introduced into the chamber 40 through the introduction portion 40, the introduced fluid causes a turbulent flow inside the chamber 40, and the turbulent flow causes the unopened staple-fiber bundles 20' to whirl. This results in opening the fibers 21 extending from the joining section 22 of each unopened staple-fiber bundle 20' as illustrated in Fig. 8(b), and the fibers 21 spread out substantially radially with the joining section 22 located at the center. In this way, the intended clump-like fiber aggregate bundles 20 are formed.

[0048]

Either gas or liquid may be used as the fluid for opening. As for gas, it is advantageous to use air from the standpoint of economy and handleability, but other gases, such as nitrogen, may be used. However, flammable or explosive gases will be difficult to
5 handle. As for liquid, it is preferable to use highly volatile liquids. It is advantageous to use water as the fluid from the standpoint of economy and handleability.

[0049]

For example, in cases of using air, which is a gas, as the fluid, a turbulent flow of gas is created inside the chamber 40 by introducing the gas into the chamber 40 from the
10 introduction portion 40 and discharging the gas from the discharge portion 42 to the outside through the use of devices such as a compressor for applying energy (pressure) to the gas and a blower/ventilator for blowing in the gas. Although the discharge air amount and the discharge pressure depend on the number of crimps and height of crimp of the fibers constituting the unopened staple-fiber bundle 20', the number, length, and thickness of the
15 fibers, the number of unopened staple-fiber bundles 20' placed inside the chamber 40, and the inner volume of the chamber, it is preferable that the discharge air amount is 0.5 to 100 m³/min and the discharge pressure is 0.1 to 1.0 MPa in order to obtain the intended clump-like fiber aggregate bundles 20.

[0050]

20 Instead of the opening process using the device illustrated in Fig. 8, a carding machine, for example, may be used for the opening process. Alternatively, it is possible to use a stirring process using a stirring rotor which is a device for mechanically pulverizing wood pulp.

[0051]

25 Then, the above-mentioned step (B) is performed, which is the step of fixing the obtained clump-like fiber aggregate bundles 20 to a substrate sheet 11. This step is described with reference to Fig. 9. The manufacturing device 50 illustrated in Fig. 9 first pays out

whole cloth 11' from a whole cloth roll 11a for the substrate sheet 11. The clump-like fiber aggregate bundles 20 will be arranged on one side of the paid-out whole cloth 11'. This arrangement is done using a suction device 51. The suction device 51 has a suction pipe 52. One end of the suction pipe 52 is located inside a container box 53 which contains a plurality
5 of clump-like fiber aggregate bundles 20. The other end of the suction pipe 52 is located above and opposing one side of the whole cloth 11' at a predetermined distance away therefrom. The other end of the suction pipe 52 has an oblong opening 52' which extends in the width direction of the whole cloth 11'.

[0052]

10 Activating the suction device 51 will suck up the clump-like fiber aggregate bundles 20 contained in the container box 53 along with air. Through this suction, the clump-like fiber aggregate bundles 20 are taken into the suction pipe 52 from one end thereof, are carried through the pipe 52, and are discharged through the opening 52' at the other end of the pipe 52 to be placed on the whole cloth 11'. The clump-like fiber aggregate bundles 20 are disposed
15 randomly. Adjusting the degree of suction and the shape of the opening 52' will allow the clump-like fiber aggregate bundles 20 to be spread all over the whole cloth 11' without leaving any space.

[0053]

20 The whole cloth 11' having the clump-like fiber aggregate bundles 20 placed thereon is then sent into an embossing device 54. The embossing device 54 includes a first roll 54a having a multitude of projections 54c dispersedly arranged on its circumferential surface, and an anvil roll 54b opposing the first roll 54a. The rolls 54a, 54b are arranged at such a distance that the projections 54c on the first roll 54a either contact or come close to the circumferential surface of the anvil roll 54b. Of the two rolls 54a, 54b, at least the first roll
25 54a is heated. Other than the present embossing device 54, it is possible to employ an embossing method (the "tip-to-tip" method) which employs a roll similar to the first roll 54a having the projections 54c in place of the anvil roll 54b which opposes the roll 54a, so that the

projections 54c on both rolls contact one another. By the effect of heat and pressure using the embossing device 54, the fibers 21 constituting the clump-like fiber aggregate bundles 20 and the whole cloth 11' are molten and hardened, thereby joining the clump-like fiber aggregate bundles 20 to the whole cloth 11'. This joining process forms a plurality of joining points 13 (see Fig. 1). As mentioned above, the clump-like fiber aggregate bundles 20 are disposed randomly on the whole cloth 11'. Thus, the joining point 13 will be formed at a random position on each clump-like fiber aggregate bundle 20. Further, there are cases where not only one joining point 13 is formed on a single clump-like fiber aggregate bundle 20, but two or more joining points 13 are formed on a single clump-like fiber aggregate bundle 20. The joining point 13 is illustrated to have a substantially dot-like (circular) shape, but instead, shapes other than a dot (circle) may be employed, such as an ellipse, triangle, rectangle, V-shape, or a cross-shape. Further, a single type or a combination of joining lines, such as straight lines, oblique lines, or curved lines, may also be used in order to increase the joining strength between the clump-like fiber aggregate bundles 20 and the whole cloth 11'.

[0054]

The clump-like fiber aggregate bundles 20 heated and pressurized by the embossing device 54 are reduced in their bulk. In view thereof, a fluid-blowing device 55 is provided downstream of the embossing device 54 and is used to blow a fluid on the clump-like fiber aggregate bundles 20 joined to the whole cloth 11'. Blowing fluid causes the fibers 21 constituting the clump-like fiber aggregate bundles 20 to flutter and open, thus restoring the bulk of the clump-like fiber aggregate bundles 20. A fluid similar to the one used in the step of opening the unopened staple-fiber bundles 20' illustrated in Fig. 8 can be used as the fluid for this blowing process. A particularly preferable fluid is air. Although the degree of blowing depends on the number of crimps and height of crimp of the fibers constituting the clump-like fiber aggregate bundle 20 joined to the whole cloth 11', the number, length, and thickness of the fibers, and the joining/embossing pattern, it is preferable that the discharge air amount is 0.5 to 100 m³/min and the discharge pressure is 0.1 to 1.0 MPa in order to obtain

the intended opening state. Other than blowing of fluid, processes such as combing with projections of a brush or a comb or rubbing may be employed for restoring the bulk of the clump-like fiber aggregate bundles 20. These processes may be employed in combination.

[0055]

5 In this way, a long cleaning sheet 10' is formed. This sheet 10' is sent into a widthwise cutting device 56. The widthwise cutting device 56 includes a first roll 56a in which ridge-like blades 56c extending in the roll's axial direction are arranged at predetermined intervals in the roll's circumferential direction, and an anvil roll 56b opposing the first roll 56a. The rolls 56a, 56b are arranged at such a distance that the ridge-like blades 56c on the first roll
10 56a either contact or come close to the circumferential surface of the anvil roll 56b. Sending the sheet 10' into the widthwise cutting device 56 cuts the sheet 10' along the width direction at predetermined intervals. Through this cutting step, the sheet 10' is made into flat sheets, thus forming the intended cleaning sheets 10.

[0056]

15 Note that in the present manufacturing method, the chemical agent applying device 35 described above with reference to Figs. 5 and 7 may be provided immediately downstream of the embossing device 54 illustrated in Fig. 9.

[0057]

Fig. 10 illustrates a manufacturing method different from the manufacturing method
20 illustrated in Fig. 9. The present manufacturing method uses the same device 50 as that used in the manufacturing method of Fig. 9, but the material used is different from that of the manufacturing method of Fig. 9. More specifically, in the present manufacturing method, instead of joining clump-like fiber aggregate bundles 20 to the whole cloth 11' for the substrate sheets 11, unopened staple-fiber bundles 20' are joined to the whole cloth 11' for the
25 substrate sheets 11. Specific processes are described below. Note that the explanation regarding the manufacturing method of Fig. 9 applies as appropriate to features that are not particularly explained below.

[0058]

First, whole cloth 11' is paid out from a whole cloth roll 11a for the substrate sheets 11. Unopened staple-fiber bundles 20' will be placed on one side of the paid-out whole cloth 11' using a suction device 51. The unopened staple-fiber bundles 20' are disposed randomly. In contrast to the method illustrated in Fig. 9 for disposing clump-like fiber aggregate bundles 20, the present manufacturing method does not require the unopened staple-fiber bundles 20' to be spread without leaving any space.

[0059]

The whole cloth 11' having the unopened staple-fiber bundles 20' placed thereon is then sent into an embossing device 54. By the effect of heat and pressure using the embossing device 54, the fibers 21 constituting the unopened staple-fiber bundles 20' and the whole cloth 11' are molten and hardened, thereby joining the unopened staple-fiber bundles 20' to the whole cloth 11'. This joining process forms a plurality of joining points 13 (see Fig. 1).

[0060]

The unopened staple-fiber bundles 20' joined to the whole cloth 11' then undergo an opening step using a fluid-blowing device 55. In this opening step, a fluid is blown to cause the fibers 21 constituting the unopened staple-fiber bundles 20' to flutter and open. By adjusting the fluid blowing pressure etc., the degree at which the fibers 21 are opened can be adjusted. In cases of using air as the fluid, the degree of blowing is set higher than the degree of blowing in the manufacturing method of Fig. 9. This is because, in the present manufacturing method, it is necessary to open the unopened fibers 21 and thus a large amount of energy is required for opening, whereas in the manufacturing method of Fig. 9, fluid blowing is performed with the aim of re-opening the fibers 21 that have already been opened.

[0061]

In this way, clump-like fiber aggregate bundles 20 are formed in a state fixed to the whole cloth 11', thereby forming a long cleaning sheet 10'. From this step on, the same procedure as that for the manufacturing method of Fig. 9 is performed, to thus obtain the

intended cleaning sheets 10.

[0062]

Next, second to eighth embodiments of the present invention will be described with reference to Figs. 11 to 18. As for these embodiments, only features that differ from those of the first embodiment will be explained, and the explanation given in the first embodiment applies as appropriate to features that are not particularly explained below. Further, in Figs. 11 to 18, the same reference symbols are assigned to component members in common with those of Figs. 1 to 10.

[0063]

10 The cleaning sheet 10 of the second embodiment illustrated in Fig. 11 has a different type of substrate sheet 11 from that of the first embodiment. More specifically, the substrate sheet 11 of the present embodiment is made of a net (scrim) 11a. The net 11a has a lattice-like form. The mesh size, the line diameter, and the distance between lines are determined in consideration of such properties as the strength of the cleaning sheet 10 and the capability of being joined with the clump-like fiber aggregate bundles 20 that constitute the cleaning section 12. Specifically, the line diameter of the net 11a is preferably 10 to 5000 μm , and more preferably 50 to 1000 μm . The line diameter may differ among different sections in the net 11a, and in that case, it is preferable that the diameter of the thicker lines take the above-mentioned values. The distance between lines in the net 11a is preferably 0.1 to 30 mm, and more preferably 5 to 15 mm. The net 11a is made of a synthetic resin, for example. The cleaning sheet 10 of the present embodiment is advantageous in that the engagement between the sheet retainers 104 and the net 11a is improved when the cleaning sheet is attached to the cleaning tool 100 illustrated in Fig. 4.

[0064]

25 The cleaning sheet 10 of the third embodiment illustrated in Fig. 12 also has a different type of substrate sheet 11 from that of the first embodiment. More specifically, the substrate sheet 11 of the present embodiment is made of a conjugate component composed of a net

(scrim) 11a and a nonwoven fabric 11b. A net similar to the one used in the second embodiment can be used for the present net 11a. A nonwoven fabric similar to the one used in the first embodiment can be used for the present nonwoven fabric 11b. The net 11a and the nonwoven fabric 11b are joined, for example, through heat-fusing or bonding with a bonding agent. In the substrate sheet 11, the net 11a is on the side of the cleaning section 12, whereas the nonwoven fabric 11b faces the opposite side from the cleaning section 12. The cleaning sheet 10 of the present embodiment achieves the same effects as the cleaning sheet of the embodiment illustrated in Fig. 11.

[0065]

The cleaning sheet 10 of the fourth embodiment illustrated in Fig. 13 differs from the first embodiment in that its cleaning section consists of multiple stripes extending in the length direction X. Specifically, the cleaning section consists of two stripes--a first cleaning section 12A and a second cleaning section 12B. Each cleaning section 12A, 12B has substantially the same width. The basis weight of the fibers 21 is also substantially the same. Each cleaning section extends in the length direction X. The substrate sheet 11 is exposed from between the cleaning sections 12A, 12B. Upon cleaning a projection, such as a non-slip stair tread or a frame beneath a door, the cleaning sections 12A, 12B of the cleaning sheet 10 of the present embodiment can clean the projection by straddling across the projection and enwrapping the projection, thus providing an advantage that the conformability to the projection and the capability of trapping dirt around the projection can further be improved. From this standpoint, the distance D between the first cleaning section 12A and the second cleaning section 12B is preferably 2 to 80 mm, and more preferably 10 to 50 mm.

[0066]

Fig. 14 illustrates a perspective of a fifth embodiment of the cleaning sheet of the present invention. The fiber aggregates constituting the cleaning section 12 consist of an aggregate of unopened staple-fiber bundles 20'. Details on the unopened staple-fiber bundles 20' are as described previously with reference to Fig. 3. The term "unopened" as

used herein refers to a state where a plurality of fibers are drawn and lined up in a single direction and constitute a linear bundle. The fibers 21 extending from the joining section 22 in each unopened staple-fiber bundle 20', as illustrated in Fig. 3, are designed to open during use of the cleaning sheet 10 of the present embodiment by friction between the sheet and a surface-to-be-cleaned. Through this opening operation, each unopened staple-fiber bundle 20' assumes a clump-like form and is made into an opened fiber bundle 20 illustrated in Fig. 3. Note that the opened fiber bundle 20 illustrated in the figure is substantially spherical, which illustrates an ideal opened state achieved when a single unopened staple-fiber bundle 20' is opened alone. Actually, however, opening is performed in a state where pressure generated upon cleaning is applied to the cleaning section 12, and thus, the opened fiber bundles 20 will assume a flat shape having a certain thickness.

[0067]

The unopened staple-fiber bundle 20' used in the present embodiment is flat as illustrated in Fig. 3, but the shape of the unopened staple-fiber bundle 20' is not limited thereto and may be, for example, cylindrical, prism-shaped, or twisted (helical).

[0068]

In the cleaning sheet 10, the unopened staple-fiber bundles 20' are arranged either randomly or regularly on one side of the substrate sheet 11 and joined to the fiber sheet 11, thus forming a cleaning section 12. The unopened staple-fiber bundles 20' may be arranged without leaving any space therebetween, or may be arranged leaving a predetermined space therebetween such that the surface of the substrate sheet 11 is exposed from between adjacent unopened staple-fiber bundles 20'. The unopened staple-fiber bundles 20' may be arranged in a single layer or may be arranged in two or more layers. In either case, it is advantageous that the unopened staple-fiber bundles 20' be arranged in such a state that the cleaning section 12 assumes an even thickness when the constituent fibers 21 are opened by the friction between the sheet and the surface-to-be-cleaned.

[0069]

As illustrated in Fig. 14, the substrate sheet 11 and the unopened staple-fiber bundles 20' are joined at joining points 13. The joining points are formed, for example, through fusion-bonding between the substrate sheet 11 and the fibers 21 constituting the unopened staple-fiber bundles 20'. Alternatively, the joining points may be formed through bonding of the substrate sheet 11 and the fibers 21. The joining points 13 may be arranged regularly or randomly. According to the manufacturing method described further below, the joining points 13 will be arranged regularly.

[0070]

The unopened staple-fiber bundles 20' do not have to be joined to the substrate sheet 11 at the positions of the joining sections 22. In other words, the joining point 13 does not have to be formed at the position of the joining section 22. The unopened staple-fiber bundles 20' may be joined to the substrate sheet 11 at any position thereon as long as the unopened staple-fiber bundles 20' are securely joined to the substrate sheet 11 and do not fall off therefrom.

[0071]

Although the total basis weight of the unopened staple-fiber bundle 20' constituting the cleaning section 12 depends on the total fineness of the unopened staple-fiber bundle 20' and the length of the fiber 21, it is preferable that the total basis weight is 10 to 1000 g/m², and more preferably 50 to 500 g/m², from the standpoint of allowing the fibers 21, in their opened state, to conform favorably to uneven surfaces to be cleaned and from the standpoint of providing voluminosity and a comfortable wiping feeling to the cleaning sheet 10 when the fibers 21 are in their opened state.

[0072]

When the cleaning sheet 10 of the present embodiment is attached as illustrated in Fig. 4 as described further above and is used to wipe a surface-to-be-cleaned, friction is caused between the cleaning section 12 and the surface-to-be-cleaned, which opens the fibers 21 in the unopened staple-fiber bundles 20'. This state is the same as the state illustrated in Figs. 1

and 2 described further above. In the cleaning sheet 10 in which the fibers 21 have been opened through cleaning, the cleaning section 12 is made up of an aggregate of opened fiber bundles 20 as illustrated in Fig. 1. It is preferable that the thickness of the cleaning sheet in the cleaning section 12, in a state where the fibers 21 have been opened, is 1 to 50 mm, and more preferably 2 to 30 mm, under a load of 300 Pa, although the thickness depends on the magnitude of the frictional force, the pressure applied during cleaning, and so forth.

[0073]

Before being opened, the fibers 21 constituting the unopened staple-fiber bundles 20' are oriented mainly in the planar direction of the cleaning section 12, as illustrated in Fig. 14. The fibers 21 oriented in the planar direction do not all extend in the same direction, but are oriented in all directions within the plane. When the fibers 21 in this state are opened, the opened fibers 21 will be oriented in all directions within the plane of the cleaning section 12, as illustrated in Figs. 1 and 2 described further above. Further, many of the fibers 21 will also be oriented in the thickness direction of the cleaning section 12. Additionally, one of the opposite ends of each fiber 21 is a free end, thus providing an extremely high degree of freedom in movement. Because the fibers 21, in their opened state, are oriented in various directions and the degree of freedom in movement thereof is extremely high, dirt can be caught among the fibers 21, regardless of the wiping direction of the cleaning sheet 10.

[0074]

Note that it is not necessary to apply any special treatment to the unopened staple-fiber bundles 20' in order to make the fibers 21 therein open successfully. This is because it is natural that fibers, which have been drawn and lined up in a single direction, can be opened by applying a frictional force thereto, which is an attribute of fiber. Put another way, it can be said that the present invention advantageously utilizes this attribute to provide a cleaning sheet that is compact and not bulky before use but that becomes bulky upon use to exhibit good cleaning capabilities. It is possible, however, to successfully open the fibers 21 constituting the unopened staple-fiber bundles 20' prior to use, such as by fluffing the fibers with the hand,

by combing with a comb or a brush, or by rubbing.

[0075]

Next, a preferred method for manufacturing the cleaning sheet 10 of the present embodiment is described with reference to Fig. 15. The present manufacturing method is roughly divided into: (i) a step of manufacturing unopened staple-fiber bundles 20'; and (ii) a step of joining the unopened staple-fiber bundles 20' to a substrate sheet 11. Step (i) of manufacturing unopened staple-fiber bundles 20' is omitted from explanation below, and reference should be made to step (A) of manufacturing clump-like fiber aggregate bundles 20 in the method of manufacturing the cleaning sheet of the first embodiment described further above with reference to Figs. 5 to 7. Below, only step (ii) will be described.

[0076]

Step (ii) is described with reference to Fig. 15. The manufacturing device 50 illustrated in Fig. 15 first pays out whole cloth 11' from a whole cloth roll 11a for the substrate sheet 11. The unopened staple-fiber bundles 20' will be arranged on one side of the paid-out whole cloth 11'. This arrangement is done using a suction device 51. The suction device 51 has a suction pipe 52. One end of the suction pipe 52 is located inside a container box 53 which contains a plurality of unopened staple-fiber bundles 20'. The other end of the suction pipe 52 is located above and opposing one side of the whole cloth 11' at a predetermined distance away therefrom. The other end of the suction pipe 52 has an oblong opening 52' which extends in the width direction of the whole cloth 11'.

[0077]

Activating the suction device 51 will suck up the unopened staple-fiber bundles 20' contained in the container box 53 along with air. Through this suction, the unopened staple-fiber bundles 20' are taken into the suction pipe 52 from one end thereof, are carried through the pipe 52, and are discharged through the opening 52' at the other end of the pipe 52 to be placed on the whole cloth 11'. The unopened staple-fiber bundles 20' are disposed randomly. Adjusting the degree of suction and the shape of the opening 52' will allow a

desired number of unopened staple-fiber bundles 20' to be arranged on the whole cloth 11'.

[0078]

The whole cloth 11' having the unopened staple-fiber bundles 20' placed thereon is then sent into an embossing device 54. This embossing device 54 has the same structure as the embossing device (see Fig. 9) used for manufacturing the cleaning sheet of the first embodiment. Accordingly, the explanation given in the first embodiment applies as appropriate to the process of joining the unopened staple-fiber bundles 20' to the whole cloth 11' using the embossing device 54.

[0079]

By joining the unopened staple-fiber bundles 20' to the whole cloth 11', a long cleaning sheet 10' is formed. This sheet 10' is sent into a widthwise cutting device 56. The widthwise cutting device 56 includes a first roll 56a in which ridge-like blades 56c extending in the roll's axial direction are arranged at predetermined intervals in the roll's circumferential direction, and an anvil roll 56b opposing the first roll 56a. The rolls 56a, 56b are arranged at such a distance that the ridge-like blades 56c on the first roll 56a either contact or come close to the circumferential surface of the anvil roll 56b. Sending the sheet 10' into the widthwise cutting device 56 will cut the sheet 10' along the width direction at predetermined intervals. Through this cutting step, the sheet 10' is made into flat sheets, thus forming the intended cleaning sheets 10.

[0080]

Note that in the present manufacturing method, the chemical agent applying device 35 described above with reference to Figs. 5 and 7 may be provided immediately downstream of the embossing device 54 illustrated in Fig. 15.

[0081]

The cleaning sheet 10 of the sixth embodiment illustrated in Fig. 16 has a different type of substrate sheet 11 from that of the fifth embodiment. More specifically, the substrate sheet 11 of the present embodiment is made of a net (scrim) 11a. Details on the net 11a are

as described in the second embodiment illustrated in Fig. 11. The cleaning sheet 10 of the present embodiment is advantageous in that the engagement between the sheet retainers 104 and the net 11a is improved when the cleaning sheet is attached to the cleaning tool 100 illustrated in Fig. 4.

5 [0082]

The cleaning sheet 10 of the seventh embodiment illustrated in Fig. 17 also has a different type of substrate sheet 11 from that of the fifth embodiment. More specifically, the substrate sheet 11 of the present embodiment is made of a conjugate component composed of a net (scrim) 11a and a nonwoven fabric 11b. The present embodiment is a combination of
10 the fifth embodiment illustrated in Fig. 14 and the third embodiment illustrated in Fig. 12. The cleaning sheet 10 of the present embodiment achieves the same effects as the cleaning sheet of the sixth embodiment illustrated in Fig. 16.

[0083]

The cleaning sheet 10 of the eighth embodiment illustrated in Fig. 18 differs from the
15 fifth embodiment in that its cleaning section consists of multiple stripes extending in the length direction X. The present embodiment is a combination of the fifth embodiment illustrated in Fig. 14 and the fourth embodiment illustrated in Fig. 13.

[0084]

The present invention has been described above according to preferred embodiments
20 thereof, but the present invention is not to be limited to the foregoing embodiments. For example, in the foregoing embodiments, the joining section 22 in the clump-like fiber aggregate bundle 20 and the unopened staple-fiber bundle 20' is formed substantially in the central area in the length direction of the fibers 21, but instead, the joining section 22 may be formed in a position deviating from the substantially-central area in the length direction of the
25 fibers 21. Alternatively, the joining section 22 may be formed on one end of the fibers 21.

[0085]

Further, the clump-like fiber aggregate bundle 20 that is used may be a clump-like

aggregate made of a plurality of first fibers oriented in one direction and a plurality of second fibers oriented in a direction intersecting with the above direction, and structured such that the first and second fibers are joined together by a joining section formed at the intersection point of the fibers, wherein the first and second fibers extending from the joining section are opened
5 into a clump-like form. The same applies to the unopened staple-fiber bundles 20'.

[0086]

In the foregoing embodiments, the cleaning sheet 10 is used, for example, by being attached to a cleaning tool as illustrated in Fig. 4. Instead, the cleaning sheet 10 may be made into a cleaning cloth having a flat bag-like shape with an inner space for insertion--as
10 disclosed in JP-A-9-299305, a former application by present Applicant--and the cleaning cloth may be attached to a hand-held cleaning tool disclosed therein. Alternatively, the cleaning sheet 10 can be held directly with the hand for cleaning.

[0087]

In the foregoing embodiments, the cleaning section 12 is formed only on one side of the
15 substrate sheet 11, but the cleaning section 12 may instead be formed on both sides of the substrate sheet 11.

[0088]

Furthermore, the present invention encompasses embodiments that combine, as appropriate, the substrate sheet illustrated in Fig. 11 or Fig. 12 and the cleaning sections
20 illustrated in Fig. 13. Likewise, the present invention encompasses embodiments that combine, as appropriate, the substrate sheet illustrated in Fig. 16 or Fig. 17 and the cleaning sections illustrated in Fig. 18.

Examples

[0089]

25 The present invention is described in further detail below according to Examples thereof. The scope of the invention, however, is not to be limited by these Examples.

[0090]

Example 1-1

(1) Manufacturing Unopened Staple-Fiber Bundle

Unopened staple-fiber bundles 20' were manufactured according to the method illustrated in Fig. 5. The fibers 21 used were made of a core/sheath conjugate fiber having a polyethylene terephthalate core and a polyethylene sheath. The fineness of the fiber was 2.2 dtex. The number of crimps in the fiber 21 was 16.51, and the height of crimp was 0.87 mm. The fiber length was approximately 45 mm. The total fineness of each unopened staple-fiber bundle 20' was approximately 3700 tex, and the weight thereof was approximately 0.13 g. A joining section 22 having a width of 5 mm was formed substantially in the central area in the length direction of the fibers 21. As an oil solution, 5% by weight of liquid paraffin, with respect to the weight of the unopened staple-fiber bundle 20', was applied to the bundle 20'.

[0091]

(2) Manufacturing Clump-Like Fiber Aggregate Bundle

The device illustrated in Fig. 8 was used to open the obtained unopened staple-fiber bundles 20' and thus form clump-like fiber aggregate bundles 20. The obtained clump-like fiber aggregate bundle 20 had its joining section 22 substantially in its center and had a substantially spherical shape (a shape like *Aegagropila linnaei*) with its fibers 21 extending radially from the joining section 22. The volume was approximately 8 cm³.

[0092]

(3) Manufacturing Cleaning Sheet

The device illustrated in Fig. 9 was used to manufacture a cleaning sheet 10. An air-through nonwoven fabric having a basis weight of 40 g/m² was used as the substrate sheet 11. The nonwoven fabric was made of a polyester/polyethylene core/sheath conjugate fiber having a fineness of 2.2 dtex. The substrate sheet 11 was 280 mm long in the length direction X and 210 mm long in the width direction Y. On one side of this substrate sheet 11, 40 pieces of clump-like fiber aggregate bundles 20 were spread, in a single layer, randomly

without leaving any space therebetween. The area in which the bundles were spread was an area 120 mm wide located in the central area, in the width direction Y, of the substrate sheet 11 and spanning the entire range in the length direction X. The clump-like fiber aggregate bundles 20 were joined to the substrate sheet 11 through heat-fusing, thereby forming a cleaning section 12. Each joining point 13 was a 3-mm-dia. circle. The joining points 13 were arranged in a lattice pattern. The pitch between adjacent joining points 13 was 20 mm in both the length direction X and the width direction Y. The total basis weight of the clump-like fiber aggregate bundles 20 in the cleaning section 12 was 155 g/m². In this way, a cleaning sheet 10 as illustrated in Fig. 1 was formed.

10 [0093]

Example 1-2

A cleaning sheet 10 illustrated in Fig. 1 was made in the same way as in Example 1-1, except that the fibers 21 used had a number of crimps of 22.32 and a height of crimp of 0.32 mm.

15 [0094]

Example 1-3

A cleaning sheet 10 illustrated in Fig. 1 was made in the same way as in Example 1-1, except that the fibers 21 used had a number of crimps of 7.5 and a height of crimp of 0.07 mm.

20 [0095]

Example 1-4

A cleaning sheet 10 illustrated in Fig. 1 was made in the same way as in Example 1-1, except that the fibers 21 used had a number of crimps of 22.86, a height of crimp of 0.24 mm, and a fineness of 4.4 dtex.

25 [0096]

Example 1-5

A cleaning sheet 10 illustrated in Fig. 13 was manufactured. The fibers 21 and the

clump-like fiber aggregate bundles 20 used were the same as those in Example 1-1. The length, in the width direction Y, of the first cleaning section 12A and the second cleaning section 12B was 50 mm, respectively. The distance D between the first cleaning section 12A and the second cleaning section 12B was 20 mm. The basis weight of the cleaning sections 12A, 12B was 155 g/m², respectively. A cleaning sheet 10 was made in the same way as in Example 1-1, except for the points mentioned above.

[0097]

Example 1-6

The number of stripes constituting the cleaning section was changed from two stripes as in Example 1-5 to three. The length, in the width direction Y, of each cleaning section was 30 mm. The distance between adjacent cleaning sections was 10 mm. The basis weight of each cleaning section was 155 g/m². A cleaning sheet 10 was made in the same way as in Example 1-5, except for the points mentioned above.

[0098]

Comparative Example 1

“Quickle” (registered trademark) Dry Sheet from Kao Corporation was employed as Comparative Example 1.

[0099]

Evaluation

The thickness of the cleaning section of the respective cleaning sheets obtained in the above Examples and Comparative Example was measured under a load of 300 Pa. The results are shown in Table 1. Further, the respective cleaning sheets obtained in the above Examples and Comparative Example were attached to the head of a “Quickle” (registered trademark) Wiper from Kao Corporation, and the conformability to various uneven surfaces-to-be-cleaned and the dirt trapping capabilities of the cleaning sheets were evaluated according to the following method. The results are shown in Table 1. The following surfaces-to-be-cleaned were used for the evaluation:

(a) Grooves of a wooden floor (“KER7UE” made by Panasonic Corporation, with V-shaped grooves 1 mm deep and 2 mm wide);

(b) Tatami mat (the rush portion);

(c) Vertical surface (the indoor baseboard portion; “QPL113T39” made by Panasonic Corporation);

(d) Sill (with a groove 4 mm deep and 21 mm wide);

(e) Rail of a sliding door (barrier-free design, with a groove 2 mm deep and 5.3 mm wide);

(f) Side surface of a doorstep (“MJT107” of the hook-on type made by Panasonic Corporation);

(g) Frame beneath a door (height: 15 mm; width: 30 mm); and

(h) Non-slip stair tread (“Suberazu” made by Kawaguchigiken, Inc.; height: 3.9 mm; width: 39.5 mm).

0.02 g of model dust (cotton linters made by Iwamoto Mineral Co. Ltd., with a diameter of under 10 μm and a length of under 0.5 mm) was measured and scattered using a 300- μm -mesh screen onto the various uneven surfaces-to-be-cleaned. The cleaning sheet was attached to the head of a “Quickle” (registered trademark) Wiper from Kao Corporation and was moved back-and-forth twice to perform wiping so that the cleaning surface of the sheet conforms to the surface-to-be-cleaned. After wiping, evaluation was made by visually inspecting the model dust remaining in the uneven sections, and vicinities thereof, of the surfaces-to-be-cleaned.

The evaluation criteria are as follows.

Conformability:

A: No dust remains in the uneven sections.

B: About one-fourth or less of the scattered amount of dust remains in the uneven sections.

C: About half or less of the scattered amount of dust remains in the uneven sections.

F: More than about half of the scattered amount of dust remains in the uneven sections.

Trapping capabilities:

A: No dust remains in the uneven sections and vicinities thereof.

5 B: About one-fourth or less of the scattered amount of dust remains in the uneven sections and vicinities thereof.

C: About half or less of the scattered amount of dust remains in the uneven sections and vicinities thereof.

F: More than about half of the scattered amount of dust remains in the uneven sections and vicinities thereof.

10 [0100]

[Table 1]

		thick- ness (mm)	uneven surfaces-to-be-cleaned							
			wooden floor grooves	uneven portions of <i>tatami</i>	vertical surface (indoor baseboard portion)	sill groove	sliding door rail	side surface of doorstop	frame beneath door	non-slip stair tread
Example 1-1	conformability	5.0	A	A	A	A	A	A	A	A
	trapping capabilities		A	A	A	A	A	A	B	B
Example 1-2	conformability	4.4	A	A	A	A	A	A	A	A
	trapping capabilities		A	A	A	A	A	A	B	B
Example 1-3	conformability	3.2	A	A	A	B	B	A	B	B
	trapping capabilities		A	A	A	C	C	B	C	C
Example 1-4	conformability	5.2	A	A	A	A	A	A	A	A
	trapping capabilities		A	A	A	A	A	A	B	B
Example 1-5	conformability	5.0	A	A	A	A	A	A	A	A
	trapping capabilities		A	A	A	A	A	A	B	B
Example 1-6	conformability	5.0	A	A	A	A	A	A	A	A
	trapping capabilities		A	A	A	A	A	A	A	A
Compa- rative Example 1	conformability	1.3	C	B	B	C	C	F	F	F
	trapping capabilities		C	B	B	F	F	F	F	F

[0101]

The results shown in Table 1 reveal that the respective cleaning sheets of the Examples have excellent conformability to uneven surfaces and excellent dirt trapping capabilities, compared to the cleaning sheet of the Comparative Example.

[0102]

5 Example 2-1

(1) Manufacturing Unopened Staple-Fiber Bundle

Unopened staple-fiber bundles 20' manufactured in the same way as in Example 1-1 were used.

[0103]

10 (2) Manufacturing Cleaning Sheet

The device illustrated in Fig. 15 was used to manufacture a cleaning sheet 10. The same substrate sheet 11 as the one used in Example 1-1 was used herein. On one side of this substrate sheet 11, 40 pieces of unopened staple-fiber bundles 20' were disposed randomly in a single layer. The area in which the bundles were disposed was an area 120 mm wide located in the central area, in the width direction Y, of the substrate sheet 11 and spanning the entire range in the length direction X. The unopened staple-fiber bundles 20' were joined to the substrate sheet 11 through heat-fusing, thereby forming a cleaning section 12. Each joining point 13 was a 3-mm-dia. circle. The joining points 13 were arranged in a lattice pattern. The pitch between adjacent joining points 13 was 20 mm in both the length direction X and the width direction Y. The total basis weight of the unopened staple-fiber bundles 20' in the cleaning section 12 was 155 g/m². In this way, a cleaning sheet 10 as illustrated in Fig. 14 was formed.

[0104]

Example 2-2

25 A cleaning sheet 10 illustrated in Fig. 14 was made in the same way as in Example 2-1, except that the fibers 21 used had a number of crimps of 22.32 and a height of crimp of 0.32 mm.

[0105]

Example 2-3

A cleaning sheet 10 illustrated in Fig. 14 was made in the same way as in Example 2-1, except that the fibers 21 used had a number of crimps of 7.5 and a height of crimp of 0.07 mm.

[0106]

Example 2-4

A cleaning sheet 10 illustrated in Fig. 14 was made in the same way as in Example 2-1, except that the fibers 21 used had a number of crimps of 22.86, a height of crimp of 0.24 mm, and a fineness of 4.4 dtex.

[0107]

Example 2-5

A cleaning sheet 10 illustrated in Fig. 18 was manufactured. The fibers 21 and the unopened staple-fiber bundles 20' used were the same as those in Example 2-1. The length, in the width direction Y, of the first cleaning section 12A and the second cleaning section 12B when in their opened state was 50 mm, respectively. The distance D between the first cleaning section 12A and the second cleaning section 12B, when in their opened state, was 20 mm. The basis weight of the cleaning sections 12A, 12B was 155 g/m², respectively. A cleaning sheet 10 was made in the same way as in Example 2-1, except for the points mentioned above.

[0108]

Example 2-6

The number of stripes constituting the cleaning section was changed from two stripes as in Example 2-5 to three. The length, in the width direction Y, of each cleaning section when in its opened state was 30 mm. The distance between adjacent cleaning sections when in

their opened state was 10 mm. The basis weight of each cleaning section was 155 g/m². A cleaning sheet 10 was made in the same way as in Example 2-5, except for the points mentioned above.

[0109]

5 Evaluation

The thickness of the cleaning section, before being used for cleaning, of the respective cleaning sheets obtained in the above Examples and Comparative Example was measured under a load of 300 Pa. The thickness was also measured in the same way after the fibers were opened through cleaning. The results are shown in Table 2. Further, the respective
10 cleaning sheets obtained in the above Examples and Comparative Example were evaluated in terms of their conformability to various uneven surfaces-to-be-cleaned and their dirt trapping capabilities, in the same way as in Example 1-1. The results are shown in Table 2. Note that Table 2 again shows the data for Comparative Example 1 shown in Table 1 to facilitate comparison.

15 [0110]

[Table 2]

		thickness (mm)		uneven surfaces-to-be-cleaned							
		before use	after opening	wooden floor grooves	uneven portions of <i>tatami</i>	vertical surface	sill groove	sliding door rail	side surface of doorstop	frame beneath door	non-slip stair tread
Example 2-1	conformability	2.3	5.0	A	A	A	A	A	A	A	A
	trapping capabilities			A	A	A	A	A	A	B	B
Example 2-2	conformability	1.9	4.4	A	A	A	A	A	A	A	A
	trapping capabilities			A	A	A	A	A	A	B	B
Example 2-3	conformability	1.6	3.2	A	A	A	B	B	A	B	B
	trapping capabilities			A	A	A	C	C	B	C	C
Example 2-4	conformability	2.3	5.2	A	A	A	A	A	A	A	A
	trapping capabilities			A	A	A	A	A	A	B	B
Example 2-5	conformability	2.0	5.0	A	A	A	A	A	A	A	A
	trapping capabilities			A	A	A	A	A	A	B	B
Example 2-6	conformability	2.0	5.0	A	A	A	A	A	A	A	A
	trapping capabilities			A	A	A	A	A	A	A	A
Compa- rative Example 1	conformability	1.3	1.3	C	B	B	C	C	F	F	F
	trapping capabilities			C	B	B	F	F	F	F	F

[0111]

The results shown in Table 2 reveal that the respective cleaning sheets of the Examples are thin before cleaning, but become bulky as a result of the fibers opening through cleaning.

- 5 Further, the results reveal that the respective cleaning sheets of the Examples have excellent conformability to uneven surfaces and excellent dirt trapping capabilities, compared to the cleaning sheet of the Comparative Example.

Industrial Applicability

[0112]

- 10 As described in detail above, the present invention can provide a cleaning sheet that conforms favorably to uneven surfaces-to-be-cleaned, that has excellent dirt trapping capabilities and trapping efficiency, that is voluminous, and that has a comfortable wiping feeling. In cases of using unopened staple-fiber bundles, the fibers therein will open in various directions and become bulky at the time of wiping a surface-to-be-cleaned, but before

use, the fibers are in their unopened state and are thus not bulky and can be stored in a compact state.

CLAIMS

[Claim 1] A cleaning sheet comprising a substrate sheet and a plurality of clump-like fiber aggregate bundles joined to at least one side of the substrate sheet to form a cleaning section, wherein each of the clump-like fiber aggregate bundles is formed by joining together, at a joining section, a plurality of fibers that have been arranged in one direction and opening those fibers extending from the joining section.

[Claim 2] The cleaning sheet according to claim 1, wherein the fibers are crimped.

[Claim 3] The cleaning sheet according to claim 1 or 2, wherein the substrate sheet includes a net.

[Claim 4] The cleaning sheet according to any one of claims 1 to 3, wherein the cleaning sheet is used with a cleaning tool that has a head and a handle connected to the head, and the substrate sheet is utilized to attach the cleaning sheet to the head.

[Claim 5] A method of manufacturing the cleaning sheet according to claim 1, the method comprising:

forming a continuous-filament bundle by joining together a plurality of continuous filaments that have been arranged in one direction with a plurality of joining sections that extend in a direction intersecting with the direction in which the continuous filaments are arranged;

forming unopened staple-fiber bundles by cutting the continuous-filament bundle between adjacent joining sections;

forming a clump-like fiber aggregate bundle by blowing a fluid on the unopened staple-fiber bundle to open the fibers extending from the joining section; and

joining a plurality of the clump-like fiber aggregate bundles to at least one side of a substrate sheet.

[Claim 6] A method of manufacturing the cleaning sheet according to claim 1, the method comprising:

forming a continuous-filament bundle by joining together a plurality of continuous

filaments that have been arranged in one direction with a plurality of joining sections that extend in a direction intersecting with the direction in which the continuous filaments are arranged;

5 forming unopened staple-fiber bundles by cutting the continuous-filament bundle between adjacent joining sections;

 joining a plurality of the unopened staple -fiber bundles to at least one side of a substrate sheet; and

10 forming clump-like fiber aggregate bundles fixed to the substrate sheet by blowing a fluid on the unopened staple-fiber bundles to open the fibers extending from the joining section.