

DESCRIPTION

Title of Invention: COMPOSITE SHEET AND METHOD FOR MANUFACTURING SAME

Technical Field

[0001]

The present invention relates to a composite sheet, which is formed into an uneven shape and in which fibers are raised from the surfaces of protrusions and recesses, and a method for manufacturing the same.

[0002]

The present invention also relates to a cleaning sheet preferably used for catching and removing hair, dust, or particulate garbage on a floor, shelves or walls.

Background Art

[0003]

Non-woven fabrics having fibers raised excel in catching of garbage or have pleasant texture, and thus it has been studied to apply the fabric to a cleaning sheet or a cosmetic sheet. As a technique of raising fibers which form the non-woven fabric, methods in which a non-woven fabric is processed using a needle punch or sandpaper, or methods in which hair is transplanted to non-woven fabric by a hair transplant technique can be considered.

[0004]

For example, Patent Literature 1 describes a non-woven fabric which is subjected to a fiber-raising treatment with a pile roller, which is used in a fiber-raising processing of woven fabrics, to break a part of the fibers forming the sheet, thereby raising the fibers. Patent Literature 2 describes a wiping sheet in which a non-woven fabric is formed by adhesion or entangling of fibers, and a part of the fibers are cut from the surface of the non-woven fabric, and a part of the fibers are disentangled and raised. Patent Literature 3 describes a non-woven fabric in which fibers are raised using a needle punch.

[0005]

According to the techniques described in Patent Literatures 1 and 2, however, the raising is performed by breaking or cutting a part of the constituent fibers, and thus fiber waste is generated, and it makes a processing machine dirty. When the resulting non-woven fabric is used for, for example, a cleaning sheet, fiber waste undesirably drops off from the sheet. In addition, cutting of the fibers provides a big damage to the non-woven fabric or the sheet. In particular, when a non-woven fabric formed by entangling fibers is used, the formed raised non-woven fabric has a problem of entangling strength. Further, when the non-woven fabric described in Patent Literature 1, the sheet described in Patent Literature 2, and the non-woven fabric described in Patent Literature 3 are used for, for example, a cleaning sheet, it is difficult to catch particulate garbage.

[0006]

On the other hand, the present applicant has previously proposed a bulky sheet in which a mesh sheet and nonwoven-fabric-like fiber aggregations formed by entangling fibers are formed into a three-dimensional uneven shape (see Patent Literature 3). According to the bulky sheet described in Patent Literature 3, the sheet can follow an uneven floor or grooves due to the uneven shape thereof, because it is used as a cleaning sheet of fibers utilizing a difference in a melting point between the mesh sheet and the fibers, and can catch efficiently hair and garbage such as cotton dust. The present applicant has previously also proposed a cleaning sheet including thick fibers (Patent Literature 4). The cleaning sheet described in Patent Literature 4 can remove stubborn dirt.

[0007]

Recently, however, requirements for cleaning sheet capable of further efficiently catching hair and garbage such as cotton dust and of sufficiently catching particulate garbage has been increased.

[0008]

Next, as a cleaning sheet, sheets mainly including a non-woven fabric such as a spun lace non-woven fabric, in which fibers forming the non-woven fabric are raised by

a fiber-raising treatment (fuzzing) are known (see, for example, Patent Literatures 1 and 2). The fiber-raising treatments described in Patent Literatures 1 and 2 are performed by applying the non-woven fabric to be treated to a peripheral surface of a roller having many needles on its peripheral surface (a counter pile roller) and rotating it. According to Patent Literatures 1 and 2, the fibers forming the non-woven fabric are caught in the needles on the roller, and the constituent fibers are cut, or the constituent fibers are cut and entangled parts are disentangled by the fiber-raising treatment to generate many raised fibers, thus resulting in an improved catching property of garbage by such fibers raised.

[0009]

The cleaning sheet is not only used for cleaning a dried surface to be cleaned (or for catching dried garbage) but also may sometimes be used for cleaning a wet surface to be cleaned (or for catching wet garbage). The cleaning sheet, therefore, is required to have a high garbage-catching property capable of easily wiping hair and garbage such as dust, and a high garbage-holding property capable of holding the garbage caught without dropping-off, regardless of whether a surface to be cleaned or garbage on a surface to be cleaned is dry or wet. The degree of dryness of the surface to be cleaned or the garbage influences on the garbage-catching property of a cleaning sheet more than a little, and when the surface to be cleaned or the garbage is wet, the garbage-catching property of the cleaning sheet may sometimes be reduced compared to a case in which they are dry. In addition to the high garbage-catching property and the high garbage-holding property, the cleaning sheet is required to have strength sufficient for practical use, and to have as few constituent fibers dropped off as possible. Cleaning sheets satisfying all of these properties, however, have not yet provided.

[0010]

Patent Literature 1: JP-2007-190254 A

Patent Literature 2: EP 0959164 A1

Patent Literature 3: US 2005/255297 A1

Patent Literature 4: US 2002/106478 A1

Summary of Invention

[0011]

The present invention, accordingly, provides a composite sheet capable of satisfying the demands described above.

[0012]

In addition, the present invention relates to a cleaning sheet showing a high catching property and holding property to hair or garbage such as dust without any relation to the dry state of the surface to be cleaned or garbage, and hardly causing dropping-off of the constituent fibers.

[0013]

According to the present invention, there is provided a composite sheet including a nonwoven-fabric-like fiber aggregation, and a mesh sheet or a thermally bonded non-woven fabric as a framework material, the fiber aggregation is integrated to one or both sides of the mesh sheet or the thermally bonded non-woven fabric in a state in which fibers forming the fiber aggregation are entangled with each other and with the framework material. The composite sheet is formed into a three-dimensional uneven shape so as to have a plurality of protrusions and recesses. The constituent fibers of the fiber aggregation are raised from the surfaces of the protrusions and the recesses. A ratio of a number of the constituent fibers which are raised from the surfaces of the recesses and have a height of 1 mm or more to a number of the constituent fibers which are raised from the surfaces of the recesses and have a height of 0.1 mm or more is 25% or more.

[0014]

In addition, according to the present invention, there is provided a cleaning sheet including a fiber aggregation and a support supporting the fiber aggregation, fibers forming the fiber aggregation being entangled with each other and with the support, thereby forming a state in which the fiber aggregation is integrally entangled with the support, wherein there are fiber ends of the constituent fibers having a length of 10 mm or longer, which formed by a fiber-raising treatment, more outward than a straight line joining contours of one surface of the cleaning sheet in a side view of the cleaning sheet.

Brief Description of Drawings

[0015]

[FIG. 1] FIG. 1 is a perspective view showing one embodiment of a composite sheet of the present invention.

[FIG. 2] FIG. 2 is an exploded perspective view of the composite sheet shown in FIG. 1.

[FIG. 3] FIG. 3 is a sectional view at a Y1-Y1 line in FIG. 1.

[FIG. 4] FIG. 4 is a schematic view showing a preferable apparatus for manufacturing the composite sheet shown in FIG. 1.

[FIG. 5] FIG. 5 is a schematic view showing a fiber-raising processing section in the processing apparatus shown in FIG. 4, as though looking from an angle.

[FIG. 6] FIG. 6 is a schematic view showing an uneven three-dimensional shape-providing processing section in the processing apparatus shown in FIG. 4, as though looking from an angle.

[FIG. 7] FIG. 7 is an enlarged sectional view of a main part of the uneven three-dimensional shape-providing processing section shown in FIG. 6.

[FIG. 8] FIG. 8 is an explanatory view of a cleaning tool used when the composite sheet of the present invention is used as a cleaning sheet.

[FIG. 9] FIG. 9(a) is schematic view showing an original fabric manufacturing step in another preferable apparatus for manufacturing the composite sheet shown in FIG. 1, and FIG. 9(b) is a schematic view showing a secondary processing (manufacturing) step in the other apparatus described above.

[FIG. 10] FIG. 10 is a schematic view showing a method for measuring the number of constituent fibers raised, and a raising height of the fiber raised.

[FIG. 11] FIG. 11 is a view showing an example in which a height of a constituent fiber raised is measured using a perpendicular line mode of a digital microscope.

[FIG. 12] FIG. 12 is a schematic perspective view showing one example of a cleaning sheet of the present invention.

[FIG. 13] FIG. 13 is a schematic sectional view of a cross-section at an I-I line in FIG. 12.

[FIG. 14] FIG. 14 is an enlarged schematic side view showing one surface (surface subjected to a fiber-raising treatment) of the cleaning sheet shown in FIG. 12.

[FIG. 15] FIG. 15 is an explanatory view of a method of measuring a protrusion

length from a fiber aggregation of a fiber end.

[FIG. 16] FIG. 16 is a plan view showing a support in the cleaning sheet shown in FIG. 12.

[FIG. 17] FIGS. 17(a) to (b) are a plan view showing a support in another embodiment of the present invention.

[FIG. 18] FIG. 18 is an outline view showing a manufacturing apparatus capable of being used in manufacture of the cleaning sheet shown in FIG. 12.

[FIG. 19] FIG. 19 is an outline view showing manufacturing apparatus (fiber-raising processing apparatus) capable of being used in manufacture of the cleaning sheet shown in FIG. 12.

Description of Embodiments

[0016]

A composite sheet of the present invention will be explained based on a preferable embodiment below, with reference to drawings. FIG. 1 shows one embodiment of a composite sheet of the present invention, and FIG. 2 is an exploded perspective view showing the composite sheet shown in FIG. 1. A composite sheet 1A of the present embodiment (hereinafter which may also be referred to as a "composite sheet 1A") is a sheet in which nonwoven-fabric-like fiber aggregations 12 are integrated to both sides 11a and 11b of a mesh sheet or a thermally bonded non-woven fabric, which serves as a framework material 11, in a state in which fibers 13 forming the fiber aggregation are entangled with each other and also with the framework material 11. In more detail, as shown in FIG. 1 to FIG. 3, the composite sheet 1A has two fiber aggregations 12, and the framework material 11, which is located between the fiber aggregations 12 and supports each of the fiber aggregation 12. Fibers 13 forming each fiber aggregation 12 are entangled with each other, and also entangled with the framework material 11, thereby integrating the framework material 11 to the fiber aggregations 12 on both sides 11a and 11b of the framework material 11. The fiber aggregation 12 is disposed on one surface 1a and the other surface 1b locating on the opposite side of the thus formed composite sheet 1A.

In the following explanation, it is generally defined that an MD direction along an orientation direction of the fiber is a longitudinal direction X, and CD direction orthogonal thereto is a width direction Y, as though looking at the orientation direction of the fibers 13 forming the fiber aggregation 12.

[0017]

To the composite sheet of the present invention, as shown in FIG. 1, were provided three-dimensional uneven shape so that the sheet has the multiple protrusions 2 and recesses 3. The protrusions 2 and the recesses 3 are formed in a protruded or recessed state in a thickness direction T. For details, the composite sheet 1A has multiple protrusions 2, 2 ... formed protruding from the other surface 1b side to the one surface 1a side. In the composite sheet 1A, the protrusions 2 are, as shown in FIG. 1, disposed at certain intervals so that they form lines in the longitudinal direction X and the width direction Y of the composite sheet 1A, whereby a staggered arrangement pattern is formed. The recesses 3, 3 ... are formed between the protrusions 2, 2 ..., and they also form a staggered arrangement pattern. The protrusions 2 and the recesses 3 alternatively appear in the longitudinal direction X, and also alternatively appear in the width direction Y. By this structure, the composite sheet 1A is formed into a three-dimensional uneven shape as a whole.

[0018]

As shown in FIG. 1, the protrusion 2 on the composite sheet 1A has an almost hemispherical shape, and the recess 3 has also the same shape as above. When the composite sheet 1A is particularly used as a cleaning sheet, it is preferable that the shape of the protrusion 2 and the interval between the protrusions on the one surface 1a are almost the same as those on the other surface 1b, because the both surfaces 1a and 1b preferably have the same properties. The protrusions 2 on the one surface 1a and the recesses 3 on the other surface 1b are in an obverse and reverse relationship, and similarly, the recesses 3 on the one surface 1a and the protrusions 2 on the other surface 1b are preferably in an obverse and reverse relationship. Further, the protrusion 2 preferably has a reversed shape of a shape of the recess 3.

[0019]

In a 10 cm × 10 cm square area in the one surface 1a of the composite sheet 1A, preferably 50 or more protrusions 2, more preferably 100 or more protrusions 2 are formed in any of the area of the one surface 1a, and preferably 850 or less protrusions 2, more preferably 600 or less protrusions 2 are formed. For more details, preferably 50 to 850 protrusions, more preferably 100 to 600 protrusions are formed in the area. When the number of the protrusions 2 is adjusted to the range described above, the

protrusions 2 and the recesses 3 are uniformly disposed, and thus when the composite sheet 1A of the present embodiment is used for, for example, a cleaning sheet, the resulting cleaning sheet can efficiently catch hair and garbage such as cotton dust, and has the excellent particulate garbage-catching property.

[0020]

When the composite sheet 1A of the present embodiment is used for, for example, a cleaning sheet, an area of the protrusion 2 in a plan view is preferably 1 mm^2 or more, more preferably 4 mm^2 or more, and preferably 100 mm^2 or less, more preferably 25 mm^2 or less, in terms of the dust-catching property and the stable maintenance of the uneven shape. For more details, the area is preferably from 1 to 100 mm^2 , more preferably from 4 to 25 mm^2 . The same applies to an area of the recess 3 in a plan view. For the same reasons, an interval between the protrusions 2 and 2 or the recesses 3 and 3 in the longitudinal direction X is preferably 1 mm or more, more preferably 4 mm or more, and preferably 20 mm or less. For more details, the interval is preferably from 1 to 20 mm, more preferably from 4 to 20 mm. The same applies to the interval between the protrusions 2 and 2 and the interval between the recesses 3 and 3 in the width direction Y.

As apparent from a preferable method for manufacturing the composite sheet 1A described below, the shape, size and arrangement of the protrusions 2 and the recesses 3 on the composite sheet 1A can be freely designed depending on an engraved pattern of an embossing roll.

[0021]

In the composite sheet of the present invention, as shown in FIGS. 1 and 3, not only the fibers 13 forming the fiber aggregation 12 are raised from the surface of the protrusions 2 but also the fibers 13 forming the fiber aggregation 12 are raised from the surface of the recesses 3. In the composite sheet of the present invention, a ratio of a number of constituent fibers which are raised from the surfaces of the recesses 3 and have a height of 1 mm or more to a number of constituent fibers which are raised from the surfaces of the recesses 3 and have a height of 0.1 mm or more, (the number of constituent fibers which are raised from the surfaces of the recesses 3 with a height of 1 mm or more/the number of constituent fibers which are raised from the surfaces of the recesses 3 and have a height of 0.1 mm or more) is

25% or more. Here, "fiber-raising" in the present invention refers to not only a state in which fiber ends protrude from the sheet surface and a state in which loop-shaped fibers protrude from the sheet surface (the fiber ends do not appear), but also cases in which an external force (physical force) caused by a machine is applied to the fiber aggregation 12, for example, the fiber aggregation 12 is subjected to a fiber-raising processing (treatment) to raise the constituent fibers so that a ratio of the number of the constituent fibers which are raised from the surfaces of the recesses 3 with a height of 1 mm or more to the number of the constituent fibers which are raised from the surfaces of the recesses 3 with a height of 0.1 mm or more is 25% or more, thereby forming a state in which the fiber ends protrude from the sheet surface or a state in which loop-shaped fibers are protruded from the sheet surface. Additionally, the ratio of the number of the constituent fibers which are raised with a height of 1 mm or more has not particularly an upper limit, and the higher the height, the more excellent the sheet, but when the ratio is about 60%, satisfactory effects can be obtained.

[0022]

In the composite sheet, there are both the fibers raised in the state in which the ends thereof protrude, and the loop-shaped fibers. For details about the composite sheet 1A, as shown in FIG. 3, the height of the constituent fibers 13 raised from the surface of the recess 3 is higher than that of the constituent fibers 13 raised from the surface of the protrusion 2. Here, the "height of the constituent fiber 13 raised (the raising height of the fiber raised)" refers to a height from the surface of the protrusion 2 or the recess 3 to a tip of the fiber raised in a natural state, and does not refer to a height from the surface of the protrusion 2 or the recess 3 in a state in which the constituent fiber 13 raised is pulled. As described in detail in a method for manufacturing the composite sheet 1A as described below, because the fiber-raising processing is performed prior to the uneven shape-providing processing, the raising heights of the fibers raised are equal to each other immediately after the fiber-raising processing treatment. As in the explanation of the method for manufacturing a composite sheet described below, the composite sheet of the present invention is subjected to a fiber-raising processing, to which an uneven shape-providing processing is applied, and roll collection and production collection are performed, thereby putting the sheet on another sheet. At that time, the constituent fibers 13, which are raised at locations in the protrusions 2 are crushed, but conditions of the fibers raised of the constituent fibers

13, which are raised at locations in the recess 3 are maintained. In the composite sheet of the present invention, thus, an apparent raising height of the constituent fibers 13 raised at the locations in the recesses 3 becomes higher in a natural state, and the sheet is formed into the state shown in FIG. 3.

[0023]

When using for, for example, a cleaning sheet, a ratio of a height (h_3) of the constituent fiber 13 which is raised at a bottom part of the recess 3 to a height (h_2) of the constituent fiber 13 which is raised at an apex part of the protrusion 2 (h_3/h_2) is preferably 1 or more, and preferably 3 or less, more preferably 2 or less, in terms of the hair-catching property and the holding property capable of holding the garbage caught without dropping-off. For more details, the ratio is preferably from 1 to 3, more preferably from 1 to 2. The height (h_2) of the constituent fiber 13 which is raised on the protrusion 2 is preferably 0.5 mm or more, more preferably 1 mm or more, and preferably 30 mm or less, more preferably 20 mm or less. For more details, the height h_2 is preferably from 0.5 to 30 mm, more preferably from 1 to 20 mm. The height (h_3) of the constituent fiber 13 which is raised on the recess 3 is preferably 0.5 mm or more, more preferably 1 mm or more, and preferably 30 mm or less, more preferably 20 mm or less. For more details, the height h_3 is preferably from 0.5 to 30 mm, more preferably from 1 to 20 mm.

The number of the constituent fibers 13 which are raised in the protrusions 2 is preferably 5 or more fibers/10 mm width, more preferably 10 or more fibers /10 mm width, and preferably 80 or less fibers/10 mm width, more preferably 50 or less fibers /10 mm width. For more details, the number is preferably 5 to 80 fibers/10 mm width, more preferably 10 to 50 fibers/10 mm width. The number of the constituent fibers 13 which are raised in the recesses 3 is preferably 5 or more fibers/10 mm width, more preferably 10 or more fibers/10 mm width, and preferably 80 or less fibers/10 mm width, more preferably 50 or less fibers/10 mm width. For more details, the number is preferably 5 to 80 fibers/10 mm width, more preferably 10 to 50 fibers/10 mm width.

The height and the number of the constituent fibers 13 raised are measured according to the following measurement methods.

[0024]

<Production of Observation Sample>

Two slightly large observation samples (about 60 to 70 mm in CD direction and about 50 mm in MD direction) were cut from the composite sheet 1A so that an observation area can be observed with a width of 50 mm, and as shown in FIG. 10, the composite sheet 1A is folded in two so as to intersect to the MD direction, and it is fixed on a black pasteboard. When the observation sample is folded in two, the sample is folded at a bend line at position where an uneven shape of the observation sample can be observed in a cross sectional view. The bend line is a line passing through almost the center of the multiple protrusions and recesses. The folded part in two to be observed is lightly rubbed 5 times with a brush (a brush No. 812 for general use manufactured by KOMERI Co., Ltd, 30 mm) in the direction from the observation sample to the black pasteboard in order to easily observe the constituent fibers raised. Here, the brushing is not performed for raising the fibers but is performed for easily observing the conditions of the fibers raised by lightly rubbing them. The brushing is controlled so that a force applied to the area to be measured 93 (stroking force) is within a range of 5 to 15 gf during the stroking with the brush. The stroking force can be measured using a balance, and it can be adjusted by reference to the measured values.

[0025]

<Actual Measurement of Number of Fibers Raised and Raising Height>

The observation sample, which is folded in two as described above, is observed with a digital microscope (Model VHX-500) manufactured by KEYENCE Corporation at 20-fold magnification. As shown in FIG. 11, measurement is performed using a perpendicular line mode in measurement modes of the digital microscope. After a reference line of the protrusion 2 or the valley part (recess 3) is set, the maximum point of the constituent fiber 13 raised is measured in the range of the protrusion 2 or the recess 3. The raising height is measured from a range of about 0.1 mm, and the values 0.1 mm or more are adopted. Two or more observation samples ($n = 2$ or more) are measured, and the raising heights of the fibers raised are actually measured, and the number of the fibers raised are counted for all protrusions 2 and recesses 3 in the observation area having a width of 50 mm. Here, the number of the constituent fibers raised in the protrusions 2 or the recesses 3 is obtained, if it is explained in details taking, for example, the protrusion 2 as an example, by obtaining the number (TN) of all fibers in all protrusions 2 in the observation range having a width of 50 mm, obtaining the total length (TL) of all protrusions 2 in the measurement range of the number of

fibers raised, as shown in FIG. 11, and converting the above number into the number of the fibers raised in the protrusions 2 per 10 mm-length. Specifically, the number can be obtained by the following formula:

The number of the constituent fibers in the protrusions 2 (fibers/10 mm) = $TN \times 10/TL$

Additionally, the number (fibers/10 mm) of the constituent fibers raised in the recesses 3 can be obtained in the same manner as above.

[0026]

The raised fiber height of the constituent fibers 13 raised is the highest height from the reference line. The fiber end of the constituent fibers 13 raised is not necessarily the highest, but the loop-shaped part may sometimes be the highest. When the constituent fibers 13 are raised in a state in which they form the loop shape covering the protrusion 2 and the recess 3, the number of the fibers is defined as one on the protrusion 2 and one on the recess 3, and the height is defined as a height measured from the reference line of the protrusion 2 and the recess 3.

In the method described above, the measurement of the raising height of the fibers raised is performed for the constituent fibers raised (fibers raised) having a height of 0.1 mm or more.

Additionally, the raising height h_2 or h_3 of the fibers raised is average values of the measured raising heights.

[0027]

A ratio of the constituent fibers with a raising height of 1 mm or more in the constituent fibers 13 raised in the recesses 3 tends to be higher than the ratio in the constituent fibers 13 raised in the protrusions 2. When fibers having a large fiber diameter are combined, however, it is difficult to crush the fibers on the protrusions 2 due to the high rigidity of the thick fibers; as a result, it is not necessary that a ratio of the fibers having a height of 1 mm or more is increased on the recesses 3. A distance (depth) from the bottom of the recess 3 to the top of the protrusion 2 is assumed as the height 1 mm.

In the constituent fibers 13 raised in the recesses 3, a ratio of the constituent

fibers raised having a raising height of 1 mm or more to the total fibers raised is preferably 30% or more, more preferably 40% or more, and preferably 95% or less. For more details, the ratio is preferably from 30 to 95%, more preferably from 40 to 95%.

In the constituent fibers 13 raised on the protrusions 2, a ratio of the constituent fibers raised having a raising height of 1 mm or more to the total fibers raised is 20% or more, more preferably 40% or more, and preferably 90% or less, more preferably 80% or less. For more details, the ratio is preferably from 20 to 90%, more preferably from 40 to 80%.

In addition, the total number of the fibers is decreased as the combination ratio of the fibers having a large fiber diameter is increased, compared to the fibers having the same basis weight and small fiber diameter. As a result, the number of the fibers raised tends to be decreased.

The ratio of the constituent fibers raised having a raising height of 1 mm or more can be obtained from the actual measurement of the number of fibers raised and the raising height described above.

[0028]

Of the constituent fibers 13 raised from the surfaces of the recesses 3, there are loop-shaped fibers as shown in FIG. 10. When the composite sheet 1A is used for, for example, a cleaning sheet, a ratio of the loop-shaped fibers in the fibers raised is preferably 2% or more, more preferably 5% or more, and preferably 70% or less, more preferably 50% or less, in terms of an effect in which particulate garbage is caught or captured so as to improve the garbage-catching ratio. For more details, the ratio is preferably from 2 to 70%, more preferably from 5 to 50%. Here, "loop-shaped fiber" does not refer to a fiber having free ends but refers to a fiber having no free ends at the both ends thereof.

The same applies to a ratio of the loop-shaped fibers in the constituent fibers 13 raised from the surfaces of the protrusions 2. The loop-shaped fibers include "a protrusion surface" to "a section part transferring from a protrusion to a recess," "a recess surface" to "a section part transferring from a recess to a protrusion," and a loop shape formed by covering the constituent fibers 13 over "a protrusion surface" to "a recess surface." The ratio of the loop-shaped fibers is measured as follows:

[0029]

[Method of Measuring Ratio of Loop-Shaped Fibers]

When the height and the number of the fibers raised are actually measured in [Method of Measuring Height of Constituent fibers Raised] described above, the number of the loop-shaped fibers and the number of all fibers raised are actually measured. The highest point of the loop-shape fibers raised from the protrusion surface or the recess surface is defined as the raising height of the fiber raised, and the number of the fibers is counted as one. When the constituent fibers cover the protrusion surface to the recess surface in a loop shape, the number of the fibers is one in each site, and the raising height is actually measured from the reference line in each site.

[0030]

When the composite sheet 1A is used for, for example, a cleaning sheet, a thickness of the composite sheet 1A, i.e., a distance between the top of the protrusion 2 in the one surface 1a and the top of the protrusion 2 in the other surface 1b, is preferably 0.5 mm or more, more preferably 1.0 mm or more, and preferably 7.0 mm or less, more preferably 4.0 mm or less. For more details, the thickness is preferably from 0.5 to 7.0 mm, more preferably from 1.0 to 4.0 mm. The thickness of the composite sheet 1A is measured under a load of 0.3 kPa using, for example, a thickness gauge manufactured by DAIEI KAGAKU SEIKI MGF. Co., Ltd. (Model FS-60DS). This load corresponds to a pressure measured when the composite sheet 1A is lightly pushed with a hand. This thickness gauge has a presser foot area of 20 cm² (a diameter of 50.5 mm).

[0031]

In addition, the composite sheet 1A has a thickness under a load heavier than the above of 0.7 kPa of preferably 0.5 mm or more, more preferably 1 mm or more, and preferably 6 mm or less, more preferably 3 mm or less. For more details, the thickness is preferably from 0.5 to 6 mm, more preferably from 1 to 3 mm, in terms of the maintenance of the bulkiness when the composite sheet 1A is used. This load almost corresponds to a load applied when the composite sheet 1A is attached to a cleaning tool and a floor or the like is cleaned with the tool. The thickness under a load of 0.7 kPa is measured, for example, by adjusting a load weight in the thickness gauge described above.

[0032]

When the composite sheet 1A is used for, for example, a cleaning sheet, a basis weight of the composite sheet 1A is preferably 30 g/m^2 or more, more preferably 40 g/m^2 or more, and preferably 110 g/m^2 or less, more preferably 80 g/m^2 or less, in terms of the sheet strength, the catching capacity, the strike-through property of materials caught, and the production efficiency. For more details, the basis weight is preferably from 30 to 110 g/m^2 , more preferably from 40 to 80 g/m^2 .

[0033]

The framework material 11 of the composite sheet 1A is provided with a three-dimensional uneven shape so that the material has multiple protrusions 2 and recesses 3. As apparent from a preferable method for manufacturing the composite sheet 1A described below, this providing of the uneven shape is based on a thermal deformation or plastic deformation, whereby this three-dimensional uneven shape is stably maintained on the framework material 11.

In the composite sheet 1A, a melting point of a material forming the framework material 11 is the lowest in fiber materials forming the composite sheet 1A, from the viewpoints described above. In a case where the framework material 11 is formed from a mesh sheet as described below, or a case where it is formed from a material other than the above such as a non-woven fabric, it is preferable that the melting point of the material forming the framework material 11 is lower than the melting points of the fiber materials 13 forming the fiber aggregation 12 described below, and if the composite sheet 1A has materials forming the composite sheet 1A other than the framework material 11 and the fiber aggregation 12, it is preferable that the melting point of the material forming the framework material is lower than melting points of those fiber materials.

[0034]

The framework material 11 of the composite sheet 1A is formed from a mesh sheet. The mesh sheet forming the framework material 11 is, as shown in FIG. 2, a latticed resin net as a whole. The mesh sheet has a wire diameter of preferably $50 \text{ }\mu\text{m}$ or more, more preferably $100 \text{ }\mu\text{m}$ or more, and preferably $600 \text{ }\mu\text{m}$ or less, more preferably $400 \text{ }\mu\text{m}$ or less. For more details, the wire diameter is preferably from 50 to $600 \text{ }\mu\text{m}$, more preferably from 100 to $400 \text{ }\mu\text{m}$. A distance between the wires is

preferably 2 mm or more, more preferably 4 mm or more, and preferably 30 mm or less, more preferably 20 mm or less. For more details, the distance is preferably from 2 to 30 mm, more preferably from 4 to 20 mm. The mesh sheet may be thermally shrinkable or not.

[0035]

As a material forming the mesh sheet, for example, materials described in the third column, lines 39-46 in US Patent No. 5,525,397 specification can be used. Various thermoplastic resins are particularly preferably used. The material forming the mesh sheet is preferably elastic, because even if a load is applied to the composite sheet 1A, the bulkiness can be maintained. Specific examples thereof may include polyolefin resins, polyester resins, polyamide resins, acrylonitrile resins, vinyl resins, vinylidene resins, and the like. The polyolefin resin may include polyethylene, polypropylene, polybutene, and the like. The polyester resin may include polyethylene terephthalate, polybutylene terephthalate, and the like. The polyamide resin may include nylon, and the like. The vinyl resin may include polyvinyl chloride, and the like. The vinylidene resin may include polyvinylidene-chloride, and the like. Modified resins thereof and mixtures thereof may also be used.

[0036]

For the framework material 11 of the composite sheet 1A, a non-woven fabric, paper, film may be used in addition to the net mesh sheet, and it is preferable to use the non-woven fabric in terms of the bonding force caused by entangling with the fiber material 13 forming the fiber aggregation 12. The non-woven fabric may include, for example, thermally bonded non-woven fabrics. As the thermally bonded non-woven fabric, air-through non-woven fabrics, spunbond non-woven fabrics, and pointbond non-woven fabrics may be used, and it is preferable to use the spunbond non-woven fabric, in terms of the strength as the framework material and the bonding force to the fiber aggregation. The spunbond non-woven fabric has preferably an air-permeability of 0.1 to $1000 \text{ cm}^3/(\text{cm}^2\text{-sec})$, in terms of the bonding to the constituent fibers 13. The spunbond non-woven fabric has a basis weight of preferably 10 to 50 g/m^2 , more preferably 10 g/m^2 or more and 30 g/m^2 or less.

[0037]

Various thermoplastic resins are preferably used as the material forming the thermally bonded non-woven fabric. Non-woven fabrics having elasticity are preferable as the material forming the thermally bonded non-woven fabric, because even if a load is applied to the composite sheet 1A, the bulkiness thereof is maintained. It should be noted to select a material having the lowest melting point among the materials forming the composite sheet. Specifically, examples may include polyolefin resins, polyester resins, polyamide resins, acrylonitrile resins, vinyl resins, vinylidene resins, and the like. The polyolefin resin may include polyethylene, polypropylene, polybutene, and the like. The polyester resin may include polyethylene terephthalate, polybutylene terephthalate, and the like. The polyamide resin may include nylon, and the like. The vinyl resin may include polyvinyl chloride, and the like. The vinylidene resin may include polyvinylidene chloride, and the like. Modified resins thereof and mixtures thereof may also be used.

[0038]

The fiber aggregations 12, which form the one surface 1a and the other surface 1b of the composite sheet 1A, are non-woven fabrics formed by fiber-entangling the fiber web mainly formed of fibers, and are laminated on the framework material 11. The fiber aggregations 12 are integrated to the framework material 11 along uneven shapes of the three-dimensional uneven shaped framework material 11. This structure gives a three-dimensional shape having multiple protrusions 2 and recesses 3 to the composite sheet 1A as a whole. The shapes of the protrusions 2 and the recesses 3 in the composite sheet 1A are, accordingly, almost the same as the shapes of the protrusions and recesses on the framework material 11.

[0039]

As the fiber aggregation 12, spun lace non-woven fabrics formed by hydroentanglement process or needle punch may be used, and in the composite sheet 1A, a spun lace non-woven fabric is used in terms of the productivity and catching property. The spun lace non-woven fabric of the fiber aggregation on the one side has a basis weight of preferably 10 g/m² or more, more preferably 15 g/m² or more, and preferably 50 g/m² or less, more preferably 40 g/m² or less, in terms of limits of a production machine, the sheet strength, and the catching property as the cleaning sheet.

For more details, the basis weight is preferably from 10 to 50 g/m², more preferably from 15 to 40 g/m². When the fiber aggregation 12 of the spun lace non-woven fabric is laminated on each surface of the framework material 11, the spun lace non-woven fabrics may have the same basis weights or different basis weights.

[0040]

As the fiber 13 forming the fiber aggregation 12, fibers usually used for forming various non-woven fabrics may be used, and examples thereof may include polyolefins such as polyethylene (PE) and polypropylene (PP); polyesters such as polyethylene terephthalate (PET) and polybutylene terephthalate (PBT); polyamides such as Nylon (a registered trademark) and nylon 6; synthetic fibers produced from a synthetic resin such as an acrylic resin (thermoplastic fiber); natural cellulose such as cotton, regenerated cellulosic fibers such as rayon, biodegradable fibers such as polylactic acid, and the like. The constituent fiber 13 may be formed of a monofilament including one resin, or a conjugated fiber including two or more resins having a melting point different from others. The conjugated fiber may include core-sheath conjugated fibers having a sheath part formed of a resin with a relatively low melting point (a low melting point resin) and a core part formed of a resin with a relatively high melting point (a high melting point resin); side-by-side conjugated fibers in which a low melting point resin and a high melting point resin are arranged in a line in a predetermined direction, and the like.

[0041]

It is preferable that the fiber aggregation 12 is formed by mixing two or more kinds of the constituent fibers 13 whose fiber diameters differ from others by double or more, in terms of the bulkiness, scraping property, and formability of a large fiber space structure. The fiber aggregation 12 has a ratio of constituent fibers having a fiber diameter of 5 to 20 μm (hereinafter which may also be referred to as fibers having a small fiber diameter) to the all constituent fibers of preferably 10% by mass or more, more preferably 30% by mass or more, and preferably 90% by mass or less, more preferably 70% by mass or less. For more details, the ratio is preferably from 10 to 90% by mass, more preferably from 30 to 70 % by mass. The fiber aggregation 12 has a ratio of constituent fibers having a fiber diameter of 20 to 60 μm (hereinafter which may also be referred to as a fiber having a large fiber diameter) to the all constituent

fibers of preferably 10% by mass or more, more preferably 30% by mass or more, and preferably 90% by mass or less, more preferably 70% by mass or less. For more details, the ratio is preferably from 10 to 90% by mass, more preferably from 30 to 70% by mass.

It is preferable that the fiber diameter of the fiber having a large fiber diameter differ from that of the fiber having a small fiber diameter by double or more, more preferably 2.5 times or more, in terms of appropriateness to a production machine, entangling property of the fiber, and the scraping property of the sheet.

The fiber diameter of the constituent fiber is measured as follows:

[0042]

[Measurement Method of Fiber Diameter]

Five constituent fibers 13 forming the fiber aggregation 12 are randomly selected, a fiber diameter of each constituent fiber 13 extracted is measured with a microscope, and an average value of the five measured values is defined as a fiber diameter of the fiber. When the fiber aggregation 12 includes two or more kinds of the constituent fibers 13 having a fiber diameter different from each other, a diameter of each fiber is measured according to the procedures described above.

It is also possible to obtain an approximate value from a calculation of fineness based on the following formulae.

$$\text{dtex} = \pi r^2 \times 10000 \times \rho \times 10^{-6}$$

$$r = \sqrt{(\text{dtex}/(\pi \rho \times 10^{-2}))}, \phi \text{ } \mu\text{m} = 2r$$

[0043]

Next, a preferable method for manufacturing a composite sheet of the present invention is explained with reference to FIG. 4 to FIG. 7. According to the present manufacturing method, first, a fiber web is laminated on one surface or both surfaces of the framework material 11. After that, the constituent fibers 13 of the fiber web are entangled with each other, and the constituent fibers 13 are entangled with the framework material 11 by high pressure of water jet, and then the resulting product is dried, whereby the nonwoven-fabric-like fiber aggregation 12 is formed from the fiber web and at the same time the fiber aggregation 12 is integrated to the framework

material 11. Subsequently, the resulting integrated sheet is supplied to a protrusion roll having multiple protrusions on its peripheral surface, whereby the one surface or both surfaces of the sheet is subjected to the fiber-raising processing, and then the sheet, which has been subjected to the fiber-raising processing, is passed through between a pair of embossing rolls, which have multiple unevenness and engaged with each other, to perform heat embossing, whereby multiple parts of the sheet are subjected to an uneven shape-providing processing so that the sheet has uneven shapes corresponding to an uneven shape of the embossing rolls.

[0044]

FIG. 4 shows a manufacturing apparatus 20, which is preferably used in a method of manufacturing the composite sheet 1A of the present embodiment. The manufacturing apparatus 20 is divided roughly, from the upstream side toward the downstream side, into an overlaying section 20A, an entangling section 20B, a fiber-raising processing section 20C, an uneven three-dimensional shape-providing processing section 20D, and a cooling section 20E.

An arrow shown in a symbol x in each drawing shows a direction of the composite sheet 1A during the manufacture and corresponds to an MD direction (longitudinal direction X) along an orientation direction of the fibers; and an arrow shown in a symbol y in each drawing shows a direction of the axis of rotation of the roll and corresponds to CD direction (a width direction Y).

[0045]

The overlaying section 20A, as shown in FIG. 4, includes, from the upstream side toward the downstream side, carding machines 21A and 21B which manufacture respectively fiber webs 10a and 10b; sending-out rolls 22 and 22 of the fiber webs 10a and 10b; and a sending-out roll 24 which sends out the belt-shaped framework material 11 from a roll original fabric 23 of the framework material 11.

[0046]

The entangling section 20B, as shown in FIG. 4, includes, from the upstream side toward the downstream side, a web-supporting belt 25A of an endless belt and water jet nozzles 26A, which entangle the constituent fibers in stream of water from one

surface (one surface, top surface) side of an overlaid product 5 described below, a web-supporting belt 25B of an endless belt and water jet nozzles 26B, which entangle the constituent fibers in stream of water from the other surface (the remaining surface, under surface) side of the overlaid product 5 described below, at the downstream side of the web-supporting belt 25A, and a dryer 27 at the downstream side of the above.

[0047]

The fiber-raising processing section 20C is a section in which fibers forming a laminate 6 (an original sheet of the composite sheet 1A) described below are subjected to the fiber-raising processing, and as shown in FIG. 4, from the upstream side toward the downstream side, includes a protrusion roll 31 having protrusions 310 on its peripheral surface, and a protrusion roll 34 having protrusions 340 on its peripheral surface. Although the protrusion roll 31 and the protrusion roll 34 are the same rolls, the protrusion roll 31 is a roll raising fibers on one surface of the laminate 6 after integration described below, and the protrusion roll 34 is a roll raising fibers on the other surface (the remaining surface) of the laminate 6 after integration described below. The protrusion rolls 31 and 34 have a cylindrical shape and are made of a metal such as aluminum alloy or steel. The protrusion rolls 31 and 34 are rotated by driving force transmitted from a driving means (not shown in the drawing) to the axis of rotation of the roll. A rotating speed (a peripheral velocity $V3$) of the protrusion roll 31 and a rotating speed (a peripheral velocity $V4$) of the protrusion roll 34 are controlled by a control section (not shown in the drawing) provided in the manufacturing apparatus 20. Here, the peripheral velocity $V3$ of the protrusion roll 31 refers to a speed on the surface of the protrusion roll 31, and similarly the peripheral velocity $V4$ of the protrusion roll 34 refers to a speed on the surface of the protrusion roll 34.

[0048]

The fiber-raising processing section 20C, as shown in FIG. 4 and FIG. 5, includes carrying rolls 32 and 33, which carry the laminate 6, to which the fiber-raising processing has not applied yet, to the protrusion roll 31 at the upstream side and downstream side of the protrusion roll 31, and carrying rolls 35 and 36, which carry the laminate 6', whose one side has been subjected to the fiber-raising processing, to the protrusion roll 34 at the upstream side and the downstream side of the protrusion roll 34. The carrying speed $V2$ of the laminate 6 is controlled by a control section (not shown in

the drawing) provided in the manufacturing apparatus 20. Here, the carrying speed V_2 of the laminate 6, which has not been subjected to the fiber-raising processing yet, refers to a speed on the surface of the laminate 6 which is supplied to the protrusion roll 31.

[0049]

Each protrusion 310 or 340 on the protrusion roll 31 or 34 has a height from the peripheral surface of the protrusion roll 31 or 34 to the top of the protrusion 310 or 340 of preferably 0.01 mm or more, and preferably 3 mm or less, more preferably 1 mm or less. For more details, the height is preferably from 0.01 to 3 mm, more preferably from 0.01 to 1 mm. A distance (a pitch) between the protrusions 310 and 340 adjacent in a circumferential direction is preferably 0.01 mm or more, and preferably 50 mm or less, more preferably 3 mm or less. For more details, the distance is preferably from 0.01 to 50 mm, more preferably from 0.01 to 3 mm. A distance (pitch) between the protrusions 310 and 340 adjacent in an axis of rotation direction is preferably 0.01 mm or more, and preferably 30 mm or less, more preferably 3 mm or less. For more details, the distance is preferably from 0.01 to 30 mm, more preferably from 0.01 to 3 mm. It is preferable that the number of protrusions 310 or 340 per unit area is from 500 to 20000 protrusions/cm², because the number of points of action of fiber-raising is increased, and thus a laminate 6' having a large amount of raised fibers can be obtained. A shape of an apex part surface of each protrusion 310 or 340 on the protrusion roll 31 or 34 is not particularly limited, and for example, a circle, a polygon, an ellipse, and the like are used. An area of the apex part surface of each protrusion 310 or 340 is preferably 0.001 mm² or more, more preferably 0.01 mm² or more, and preferably 20 mm² or less, more preferably 1 mm² or less. For more details, the area is preferably from 0.001 to 20 mm², more preferably from 0.01 to 1 mm².

[0050]

In the manufacturing apparatus 20 of the present embodiment, in order to fiber-raise the laminate 6, to which the fiber-raising processing has not been applied yet, more efficiently, as shown in FIG. 5, a position of the carrying roll 33, located on the downstream side of the protrusion roll 31, is set higher than a position of the protrusion roll 31, and the laminate 6, to which the fiber-raising processing has not been applied yet, is brought into contact with a contact surface of the protrusion roll 31 at a jamb angle α of preferably 10° or more, more preferably 30° or more, and preferably 180° or

less, more preferably 120° or less. For more details, the laminate 6 is brought into contact with the contact surface at a jamb angle α of preferably 10 to 180° , more preferably 30 to 120° . It is also preferable that the protrusion roll 34 is brought into contact at the same jamb angle α as above.

[0051]

The uneven three-dimensional shape-providing processing section 20D is, as shown in FIG. 4 and FIG. 6, a section in which multiple parts of the laminate 6', to which the fiber-raising processing has been applied, are subjected to a thermal deformation or plastic deformation processing. In the manufacturing apparatus 20 of the present embodiment, as shown in FIG. 4 and FIG. 6, a steel-match embossing roller 43 formed of a pair of uneven rolls 41 and 42 is provided, and the steel-match embossing roller 43 is attached with a heating means (not shown in the drawing) so that the roller can be heated to a predetermined temperature. The "thermal deformation or plastic deformation" processing herein refers to deformation of a thermoplastic resin by heating to a softening temperature thereof or higher and maintenance of the resulting shape. The "softening point" refers to a temperature at which a thermoplastic resin can be deformed by a mechanical force, or the like.

The steel-match embossing has a characteristic in which the uneven rolls are not brought into contact with each other to engage with each other, but the protrusions and the recesses seemingly engage with each other while a clearance (gap) mechanically set is maintained.

[0052]

In a pair of the uneven rolls 41 and 42, one roll 41 has multiple protrusions 410 on its peripheral surface, and the other roll 42 has recesses 420 into which the protrusions 410 on the roll 41 are inserted at positions corresponding to the protrusion 410 on its peripheral surface. A pair of the uneven rolls 41 and 42 has a cylindrical shape, and is made of a metal such as aluminum alloy or steel. The manufacturing apparatus 20 of the present embodiment includes a so-called steel-match embossing roller 43 formed of a pair of the uneven rolls 41 and 42, in which the protrusion 410 and the recess 420, which engage with each other, are formed on the peripheral surfaces. As shown in FIG. 7, the steel-match embossing roller 43 is formed so that the multiple protrusions 410 formed on the peripheral surface of the roll 41 and the multiple recesses

420 formed on the peripheral surface of the roll 42 engage with each other (which are not brought into contact with each other, as described above), and the multiple protrusions 410 are disposed uniformly and regularly in a direction of the axis of rotation of the roll 41 and the circumferential direction. A pair of the rolls 41 and 42 is rotated by a driving force transmitted from a driving means (not shown in the drawing) using a gear (not shown in the drawing). It is preferable to transmit the driving force to a pair of the rolls using the gear, for avoiding the disappearance of the fiber-raising state of the constituent fiber raised.

Rotating speeds of a pair of the rolls 41 and 42 are controlled by a control section (not shown in the drawing) provided in the manufacturing apparatus 20.

[0053]

The shape of the protrusion 410 of the peripheral surface of the roll 41 may be a circle, a tetragon, an ellipse, diamond shape, rectangle (a side in a carrying direction or a direction orthogonal to the carrying direction is long) in a plain view, and the circle is preferable because the reduction of the strength of the laminate 6' to which the fiber-raising processing has been applied is low. The shape of the protrusion 410 in the side view may include a trapezoid, a tetragon, a curved shape, and the like. The trapezoid is preferable because of small rubbing during the roll rotation, and a trapezoid having a base angle of 70° to 89° is more preferable. When fine protrusions and recesses are formed in advance on a part of the protrusion 410 on the roll 41 with which the laminate 6' is brought into contact, fiber-raising treatment effect and the conditions of the fibers raised can be recovered when the laminate 6" is peeled off from the roll 41 after the deformation.

[0054]

In the uneven three-dimensional shape-providing processing section 20D, each protrusion 410 on the roll 41 has a height h from the peripheral surface of the roll 41 to the top of the protrusion 410 is preferably 1 mm or more, more preferably 2 mm or more, and preferably 10 mm or less, more preferably 7 mm or less. For more details, the height h is preferably from 1 to 10 mm, more preferably from 2 to 7 mm. A distance (pitch P_1) between the protrusions 410 adjacent in the circumferential direction is preferably 0.01 mm or more, more preferably 1 mm or more, and preferably 20 mm or less, more preferably 6 mm or less. For more details, the pitch P_1 is preferably from

0.01 to 20 mm, more preferably from 1 to 6 mm. A distance (pitch P_2 (not shown in the drawing)) between the protrusions 410 adjacent in the direction of the axis of rotation is preferably 0.01 mm or more, more preferably 1 mm or more, and preferably 20 mm or less, more preferably 6 mm or less. For more details, the pitch P_2 is preferably from 0.01 to 20 mm, more preferably from 1 to 6 mm. The shape of the apex part surface of each protrusion 410 on the roll 41 is not particularly limited, and may be, for example, a circle, a polygon, an ellipse, and the like. An area of the apex part surface of each protrusion 410 is preferably 0.01 mm^2 or more, more preferably 0.1 mm^2 or more, and preferably 500 mm^2 or less, more preferably 10 mm^2 or less. For more details, the area is preferably from 0.01 to 500 mm^2 , more preferably from 0.1 to 10 mm^2 . An area of each base surface between the adjacent protrusions 410 is preferably 0.01 mm^2 or more, more preferably 0.1 mm^2 or more, and preferably 500 mm^2 or less, more preferably 10 mm^2 or less. For more details, the area is preferably from 0.01 to 500 mm^2 , more preferably from 0.1 to 10 mm^2 . An edge part of the protrusion 410 is preferably R-shaped. In this case, the area of the surface of the protrusion 410 is an intermediate point of R (the protrusion is projected from the top).

[0055]

In the uneven three-dimensional shape-providing processing section 20D, each recess 420 in the roll 42 is, as shown in FIG. 6 and FIG. 7, disposed at a position corresponding to each protrusion 410 on the roll 41. Each recess 420 in the roll 42 has, as shown in FIG. 7, a depth D of the engagement of each protrusion 410 on the roll 41 and each protrusion in the roll 42 (a length of a part in which each protrusion 410 and each recess 420 are overlaid) of preferably 0.1 mm or more, more preferably 1 mm or more, and preferably 10 mm or less, more preferably 8 mm or less. For more details, the depth D is preferably from 0.1 to 10 mm, more preferably from 1 to 8 mm. It is preferable that there is a space between the apex part of the protrusion 410 on the roll 41 and the bottom part of the recess 420 in the roll 42 so that the laminate 6' is not sandwiched between them when the laminate 6' to which the fiber-raising processing has been applied is supplied, because the laminate 6'' obtained after the deformation processing is not crushed by the engagement and the fiber-raising state does not disappear.

[0056]

The uneven three-dimensional shape-providing processing section 20D has, as shown in FIG. 4 and FIG. 6, carrying rolls 44 and 45 which carries the laminate 6' to which the fiber-raising processing has been applied to the steel-match embossing roller 43 at the upstream side and the downstream side of the steel-match embossing roller 43.

[0057]

The cooling section 20E has, as shown in FIG. 4, an air blow duct 28 facing one surface of the laminate 6" obtained after the deformation processing, and vacuum conveyor 29 facing the other surface of the laminate 6". Cold wind blows from the air blow duct 28 toward the laminate 6". On the other hand, the vacuum conveyor 29 is formed of an endless mesh belt, which carries the laminate 6". The vacuum conveyor 29 has a structure in which the cold wind blown from the air blow duct 28 through the mesh belt is sucked. The cooling section 20E is not limited to the above, and other cooling means may be used. For example, a water-cooled roll through which cooling water is passed, or a vacuum roll capable of sucking air toward the inside from the peripheral surface thereof may be used. It can also be expected to obtain an effect of raising fibers, which fall down by air blown from the air blow duct, during the uneven shape-providing processing.

[0058]

Next, one embodiment of the method for manufacturing a composite sheet of the present invention is explained using the manufacturing apparatus 20 of the present embodiment, with reference to FIG. 4 to FIG. 7.

First, fiber webs 10a and 10b are, respectively, continuously sent out from the carding machines 21A and 21B in the overlaying section 20A through the sending-out rolls 22 and 22. On the other hand, a roll original fabric 23 of the framework material 11 is disposed between the carding machines 21A and 21B, and the framework material 11 is sent out from the sending-out roll 24 of the roll original fabric 23. The fiber webs 10a and 10b are, respectively, put on both sides of the framework material 11 by the sending-out rolls 22 and 22 to form an overlaid product 5.

[0059]

Subsequently, in the entangling section 20B, both surfaces of the overlaid

product 5, which is moved and carried to the web-supporting belt 25, are subjected to the entangling treatment by high pressure jet stream of water, which jets out from the water jet nozzles 26A and 26B. By this process, the fibers 13 forming the fiber webs 10a and 10b in the overlaid product 5 are entangled to form the fiber aggregations 12, and at the same time the constituent fibers 13 are entangled with the framework material 11, thereby obtaining a laminate 6 in which the three components are entangled, and then water is removed therefrom by the dryer 27 to obtain the laminate 6. This laminate 6 is an original sheet of the composite sheet 1A finally manufactured.

[0060]

Next, in the fiber-raising processing section 20C, the laminate 6 is subjected to the fiber-raising processing in which the fibers 13 forming the laminate 6, i.e., the fibers 13 forming the fiber aggregation 12, which forms the original sheet of the composite sheet 1A, are raised. In the present embodiment, as shown in FIG. 4, the laminate 6 is supplied to the protrusion roll 31, having protrusions 310 formed on its peripheral surface, by the carrying rolls 32 and 33; the fibers 13 forming the fiber aggregation 12, which forms the laminate 6, are raised from one surface (the top surface) of the laminate 6 by the protrusion roll 31; the laminate 6 having raised fibers on one surface (the top surface) is supplied to the protrusion roll 34 having protrusions 340 on its peripheral surface by the carrying rolls 35 and 36; and the fibers 13 forming the fiber aggregation 12, which forms the laminate 6, are also raised from the other surface (the under surface) of the laminate 6 by the protrusion roll 34.

[0061]

In the present embodiment, it is preferable that, as shown in FIG. 4 and FIG. 5, the rotation direction of the protrusion roll 31 is set at a direction opposite to the carrying direction x of the laminate 6, because the fibers 13 forming the laminate 6 are efficiently raised from the surface of the laminate 6, and the laminate 6' having a small amount of neck-ins and wrinkles can be obtained. When the roll 31 is rotated in the opposite direction as above, a value of $V3/V2$ is 0.3 or more, preferably 1.1 or more, more preferably 1.5 or more, and is 20 or less, more preferably 15 or less, more preferably 12 or less. For more details, it is preferable that the value of $V3/V2$ is 0.3 to 20, $V3 > V2$ is more preferable, it is even more preferable that the value of $V3/V2$ is from 1.1 to 15, and it is even more preferable that the value is from 1.5 to 12, because

sufficient fiber-raising can occur and only a small amount of the fibers can entangle to the roll. The rotation in the opposite direction and the difference in the peripheral velocity increase the amount of the fibers raised. When the protrusion roll 31 is not rotated in the opposite direction but is rotated in a direction forward to the carrying direction x of the laminate 6, the relationship between the carrying speed $V2$ of the laminate 6 and the peripheral velocity $V3$ of the protrusion roll 31, the value of $V3/V2$, is preferably 1.1 or more, more preferably 1.5 or more, even more preferably 2 or more, and preferably 20 or less, more preferably 10 or less, even more preferably 8 or less. For more details, the $V3/V2$ is preferably from 1.1 to 20, more preferably from 1.5 to 10, even more preferably from 2 to 8.

[0062]

The rotation direction of the protrusion roll 34 is the same as the rotation direction of the protrusion roll 31. It is preferable that it is rotated in the direction opposite to the carrying direction x of the laminate 6. When it is rotated in the opposite direction as above, a value of $V4/V2$ is 0.3 or more, preferably 1.1 or more, more preferably 1.5 or more, and is 20 or less, preferably 15 or less, more preferably 12 or less. For more details, it is preferable that the value of $V4/V2$ is 0.3 to 20, $V4 > V2$ is more preferable, it is even more preferable that the value of $V4/V2$ is from 1.1 to 15, and it is even more preferable that the value is from 1.5 to 12, because sufficient fiber-raising can occur and only a small amount of the fibers can entangle to the roll. The rotation in the opposite direction and the difference in the peripheral velocity increase the amount of the fibers raised. When the protrusion roll 34 is not rotated in the opposite direction but is rotated in a direction forward to the carrying direction x of the laminate 6, the relationship between the carrying speed $V2$ of the laminate 6 and the peripheral velocity $V4$ of the protrusion roll 34, the value of $V4/V2$, is preferably 1.1 or more, more preferably 1.5 or more, even more preferably 2 or more, and preferably 20 or less, more preferably 10 or less, even more preferably 8 or less. For more details, the $V4/V2$ is preferably from 1.1 to 20, more preferably from 1.5 to 10, even more preferably from 2 to 8.

[0063]

The conditions of the fibers raised can be arbitrarily controlled by the speed of the roll and the shape of the protrusion roll, i.e., a peripheral velocity ratio is suitably

changed by the state of the protrusion roll. Alternatively, the conditions of the fibers raised can also be changed arbitrarily by appropriately changing the shape of the protrusion roll while the peripheral velocity ratio is maintained. The conditions of the fibers raised show the number of fibers raised and the raising height of the fiber raised.

[0064]

After that, in the uneven three-dimensional shape-providing processing section 20D, multiple parts of the laminate 6' are subjected to the uneven shape-providing processing so that multiple protrusions 2 and recesses 3 are formed on the laminate 6' to which the fiber-raising processing is applied. In the present embodiment, as shown in FIG. 4 and FIG. 6, the laminate 6' to which the fiber-raising processing has been applied is supplied to between a pair of the rolls 41 and 42 of the steel-match embossing roller 43 in the uneven three-dimensional shape-providing processing section 20D by the carrying rolls 44 and 45, and the laminate 6' is subjected to the deformation processing. Specifically, as shown in FIG. 6 and FIG. 7, the laminate 6', which is carried by the carrying rolls 44 and 45, is compressed between the multiple protrusions 410 on one roll 41 and the multiple recesses 420 in the other roll 42, and multiple parts of the laminate 6' to which the fiber-raising processing has been applied are subjected to the deformation processing in the carrying direction x and the width direction y orthogonal to the carrying direction, thereby obtaining the laminate 6'' to which the deformation processing has been applied. To the laminate 6'' to which the deformation processing has been applied are provided with an uneven shape corresponding to the uneven shape on the roll 41.

[0065]

In the uneven three-dimensional shape-providing processing section 20D, it is preferable to perform the deformation processing at a temperature equal to or higher than a softening point of a thermoplastic resin forming the framework material 11 of the laminate 6', for obtaining the laminate 6'' having an excellent cushioning property by leaving the uneven shape caused by the rolls 41 and 42 to the laminate 6' to which the fiber-raising processing has been applied, and for obtaining the laminate 6'' having an excellent garbage-catching property by raising the fibers in the uneven shaped recesses. It is also effective to perform the processing at a temperature equal to or higher than a melting point of the thermoplastic resin. This process can securely provide the uneven

shape to the framework material 11, and the uneven shape can be stably maintained.

[0066]

When the composite sheet 1A is used for a cleaning sheet, it is preferable that the processing in the uneven three-dimensional shape-providing processing section 20D is performed in conditions in which the dust-catching property is not reduced in the fiber aggregations 12 (the fiber webs 10a and 10b) in the laminate 6' to which the fiber-raising processing has been applied. For example, in a case in which the fibers 13 forming the fiber aggregations 12 (the fiber webs 10a and 10b) includes a thermoplastic resin, if the deformation processing is performed at a temperature at which the thermoplastic resin is molten, the dust-catching property in the fiber aggregation 12 (the fiber webs 10a and 10b) is reduced. It is preferable, accordingly, that the melting point of the material forming the framework material 11 (a mesh sheet, or a thermally bonded non-woven fabric) is the lowest in the melting points of the fiber materials forming the composite sheet 1A. When both the framework material 11 and the fiber aggregations (fiber webs 10a and 10b) are formed of thermoplastic resins, it is preferable that a melting point of a thermoplastic resin forming the framework material 11 is lower than melting points of thermoplastic resins forming the fiber aggregations 12 (the fiber webs 10a and 10b). Under this condition, the deformation processing can be performed at a temperature equal to or higher than the melting point of the framework material, as described above, if the temperature is equal to or higher than the softening point of the thermoplastic resin forming the framework material 11 and is equal to or lower than the melting point of the constituent fiber 13.

[0067]

The laminate 6" to which the deformation processing has been applied and the uneven shape is provided is in a condition in which its temperature is high by the deformation processing. If the high temperature state of the uneven shape is continued after the form-providing, the bulkiness of the three-dimensional framework material 11, which is obtained by providing the uneven shape, may be possibly reduced. Then, the laminate 6" is passed through the cooling section 20E to cool it, whereby the desired composite sheet 1A in which the uneven shape of the framework material 11 in the laminate 6" is fixed is continuously manufactured. There is a case in which this cooling section 20E is not necessary depending on the condition of deformation

processing (for example, a case of a low heating temperature), and in such a case, the uneven shape is provided to the laminate 6' to which the fiber-raising processing has been applied, to continuously manufacture the desired composite sheet 1A.

[0068]

The continuous composite sheet 1A manufactured is usually, as shown in FIG. 4, wound around a roll winder and stored in a state in which the sheet is wound. When the sheet is stored in such a rolled state, the fibers raised from the surface of the protrusions 2 on the composite sheet 1A are easily crushed. In the composite sheet 1A, accordingly, as shown in FIG. 3, the height of the constituent fibers raised from the surfaces of the recesses 3 is higher than the height of the constituent fibers raised from the surfaces of the protrusions 2.

When the continuous composite sheet 1A manufactured is, as shown in FIG. 4, subjected to a product processing such as folding and pilling up in a product processing and wrapping section, the fibers raised from the surfaces of the protrusions 2 on the composite sheet 1A are also easily crushed. In such a case, in the composite sheet 1A, as shown in FIG. 3, the height of the constituent fibers raised from the surfaces of the recesses 3 is also higher than the height of the constituent fibers raised from the surfaces of the protrusions 2.

[0069]

According to the method for manufacturing the composite sheet 1A of the present embodiment, even if the uneven shape of the composite sheet 1A is once crushed by storing it in the rolled state or the product state, the uneven shape can be recovered or the constituent fibers, which have been crushed on the surfaces of the protrusions 2, can be raised again by subjecting it to, for example, a hot air treatment in later use.

[0070]

An oil agent may be applied to the thus manufactured composite sheet 1A according to the use. The oil agent includes preferably at least one kind of oil selected from mineral oil, synthetic oil, silicone oil, and surfactants. The mineral oil may include paraffin hydrocarbons, naphthene hydrocarbons, aromatic hydrocarbons, and

the like. The synthetic oil may include alkyl benzene oil, polyolefin oil, polyglycol oil, and the like. The silicone oil may include chain dimethyl polysiloxane, cyclic dimethyl polysiloxane, methyl hydrodiene polysiloxane, various modified silicones, and the like. The surfactant may include long chain monoalkyl trimethyl ammonium salts, long chain dialkyl dimethyl ammonium salts, and long chain monoalkyl dimethyl benzyl ammonium salts, which have an alkyl group or alkenyl group with 10 to 22 carbon atoms as a cationic surfactant; and polyethylene glycol ether surfactants such as polyoxyethylene (6 to 35 moles) long chain alkyl or alkenyl (primary or secondary C₈-C₂₂) ethers and polyoxyethylene (6 to 35 moles) alkyl (C₈-C₁₈) phenyl ethers, polyoxyethylene polyoxypropylene block copolymers, glycerin-fatty acid esters, sorbitan-fatty acid esters, polyhydric alcohol surfactants such as alkyl glycosides, and the like, as a non-ionic surfactant. The applying step may be performed either prior to or after the uneven three-dimensional shape-providing processing section 20D.

[0071]

The composite sheet 1A manufactured using the manufacturing apparatus 20 may be used for, for example, a cleaning sheet. The composite sheet 1A is, as shown in FIG. 1, formed into the three-dimensional uneven shape so as to have the multiple protrusions 2 and the recesses 3, and the fibers 13 forming the fiber aggregation 12 are raised from not only the surfaces of the protrusions 2 but also the surfaces of the recesses 3. When the composite sheet 1A is used for the cleaning sheet, accordingly, the hair and the garbage such as cotton dust can be further efficiently caught, and the particulate garbage can be sufficiently caught.

In particular, when the composite sheet 1A is used for the cleaning sheet, as shown in FIG. 8, the sheet is attached to a head part 71 in a cleaning tool 7 including the head part 71 and a handle 72 connecting to the head part 71, which is used. The attached surface (the bottom surface) of the head part 71 is rectangle-shaped in a plan view, and the composite sheet 1A is attached, for example, so that the longitudinal direction of the head part 71 agrees with the MD direction along the orientation direction of the fibers forming the composite sheet 1A. The composite sheet 1A is disposed on the bottom surface of the head part 71 so that the fiber-raising surface faces outward of the head part 71 (a direction of the surface to be cleaned during the cleaning) when it is attached, next both side edge parts along the longitudinal direction of the composite sheet 1A are folded back on the top side of the head part 71, and the folded

two side edge parts are pushed into multiple flexible sheet-holding parts 73 having slits in the head part 71 to fix them, which is used. When the cleaning tool 7 to which the composite sheet 1A is attached is used in a usual manner, the cleaning is performed by moving (in particular, back and forth moving) the head part 71 in the width direction thereof. The cleaning direction of the cleaning tool 7 is, accordingly, the width direction (the direction orthogonal to the longitudinal direction) of the head part 71. The cleaning tool 7 to which the composite sheet 1A is attached may be used for, for example, wiping a hard surface such as a wooden floor, wall, ceiling, glass, tatami mat, mirror or furniture, home appliance, outer wall of a house, or body of a car.

[0072]

When the cleaning tool 7 to which the composite sheet 1A is attached is used for, in particular, wiping the wooden floor, the particulate garbage is easily three-dimensionally held in the recesses 3, because the constituent fibers 13 are raised from the surfaces of the recesses 3, the particulate garbage held in the recesses 3 is entangled with the constituent fibers 13, and thus it is difficult to drop the particulate garbage off therefrom, thus resulting in the improved catching efficiency.

[0073]

The present invention is not limited to the embodiment described above.

For example, both one surface 1a and the other surface 1b of the composite sheet 1A described above are, as shown in FIG. 1, subjected to the fiber-raising processing, but only either one of the surfaces may be subjected to the fiber-raising processing. When only one surface (either only one surface 1a or only the other surface 1b) is subjected to the fiber-raising processing like this, the fiber-raising processing section 20C in the manufacturing apparatus 20 may include only either one of the protrusion roll 31 and the protrusion roll 34.

[0074]

The composite sheet 1A described above is, as shown in FIG. 1, formed into the three-dimensional uneven shape so as to have the multiple protrusions 2 and recesses 3, and the protrusions 2 and the recesses 3 are arranged in the staggered pattern, but for increasing the design characteristic, the protrusions 2 and the recesses 3 may be

arranged in a stripe shape, or some design may be provided to the protrusions 2 and the recesses 3. The fibers may be raised over the whole surfaces of the protrusions 2 and the recesses 3, or after the fibers may be partly raised from the sheet surface, the uneven shape is provided thereto; whereby the fibers can be partly raised in the uneven shape.

The composite sheet 1A described above may be used for cosmetics, sheets for cosmetics, or medical uses in addition to the cleaning sheet.

[0075]

The manufacturing apparatus 20 used in the method for manufacturing the composite sheet 1A includes, as shown in FIG. 4, the protrusion rolls 31 and 34 having the protrusions 310 and 340 on the peripheral surface thereof in the fiber-raising processing section 20C. The apparatus may include a pair of tooth groove rolls having tooth grooves which engage with each other on the peripheral surfaces thereof, rolls to which knurling is applied, rolls to which welding is applied, or card wires, instead of the protrusion rolls 31 and 34. The roll may be a material having frictional resistance, for example, rubber rolls or sand rolls provided with rubber or sand paper on the peripheral surface thereof. Further, the formation of the laminate 6 of the composite sheet 1A in the overlaying section 20A, the entangling section 20B, the fiber-raising processing in the fiber-raising processing section 20C, and the deformation processing in the uneven three-dimensional shape-providing processing section 20D may be continuously performed, or intermittently performed.

[0076]

A method for intermittently performing the overlaying section in which the laminate 6 of the composite sheet 1A is formed, the entangling section, the fiber-raising processing, and the deformation processing is specifically explained in detail using FIG. 9.

A manufacturing apparatus 20' shown in FIG. 9 is divided into an original fabric manufacturing of a laminate 6 (an original sheet prior to processing) step (FIG. 9 (a)) including an overlaying section 20A and an entangling section 20B, and a secondary processing (manufacturing) step (FIG. 9 (b)) including a fiber-raising processing section 20C, an uneven shape-providing processing section 20D, a cooling section 20E, and a subsequent roll-taking step or productization step. The original fabric manufacturing step is, as shown in FIG. 9 (a), a step in which an intermediate

product is manufactured in an original fabric-rolled state, and the productivity can be optimized and the mass production can be realized by increasing the size of the apparatus. In the secondary processing step, as shown in FIG. 9 (b), when an original fabrics having slits equal to the product width is used, reduction of a cost for fixing by miniaturization of the apparatus, and the change of a model by specification change of a sheet product can be easily made. According to a method using the manufacturing apparatus 20' shown in FIG. 9 in which the original fabric manufacturing step and the secondary processing (manufacturing) step are intermediately performed, accordingly, influences on the upstream steps or downstream steps can be reduced, when a production speed in the original fabric-manufacturing step (FIG. 9 (a)) is quite different from a production speed in secondary processing step (FIG. 9 (b)), or when the manufacturing place is separated or troubles are caused. In the secondary processing step, the original fabric may be once wound after the secondary processing, and then the products may be manufactured, or the productization step may be continuously performed after the secondary processing.

[0077]

Next, a cleaning sheet of the present invention is explained based on a preferable embodiment with reference to drawings. A cleaning sheet 1B of the present embodiment has, as shown in FIG. 12 and FIG. 13, a support 3b supporting a fiber aggregation 12b and a fiber aggregation 2b, and the fibers forming the fiber aggregation 2b are entangled with each other, and also with the support 3b; thereby to form a state in which the fiber aggregation 2b is integrally entangled with the support 3b. The support 3b exists inside the cleaning sheet 1B in a thickness direction, and as shown in FIG. 13, upper and lower surfaces of the support 3b are covered with the fiber aggregations 2b. One surface 1ab and the other surface 1bb at the opposite position of the cleaning sheet 1B are formed of the fiber aggregations 2b. The cleaning sheet 1B is a dry cleaning sheet which is not deliberately impregnated with liquid such as aqueous detergent.

[0078]

The fiber aggregation 2b is a non-woven fabric formed by fiber-entangling the fiber web mainly formed of fibers. The fiber aggregation 2b in the present embodiment is formed by entangling the fiber web in stream of water, as described

below, and is a so-called spun lace non-woven fabric. The fiber aggregation 2b in the present embodiment has a larger degree of freedom of the constituent fiber than a fiber aggregation formed only by melting or bonding the constituent fibers (for example, an air-through non-woven fabric or a spunbond non-woven fabric), because it is formed only by entangling the constituent fiber. For that reason, the catching property and the holding property of the constituent fibers to hair and garbage such as fine dust are excellent, the touch is soft, the sheet easily follows a surface to be cleaned and it is difficult to damage the surface to be cleaned.

[0079]

One of the main characteristics of the cleaning sheet 1B of the present embodiment is, as shown in FIG. 14, the existence of fiber ends 21b of constituent fibers with a length of 10 mm or more (hereinafter which may also be referred to as a long fiber end) more outward than a straight line BLb joining contours of one surface 1ab of the cleaning sheet 1B (outward of the cleaning sheet 1B or the fiber aggregations 2b) in a side view of the cleaning sheet 1B. The length of the fiber end is, accordingly, a length of a part (end part) protruding outward the fiber aggregation 2b in the constituent fiber, which may also be referred to as a "protrusion length from the fiber aggregation". The long fiber end 21b is, as described below, a part in which the constituent fiber is not cut by the fiber-raising of the fiber aggregation 2b, is partly pulled out from the fiber aggregation 2b, and reaches more outward than the surface (contour) of the fiber aggregation 2b, and thus it is the fiber end of the original constituent fiber (fiber end prior to the fiber-raising treatment), but is not a cut fiber end generated by cutting the constituent fiber. End parts opposite to the long fiber end 21b in the constituent fibers having the long fiber ends 21b exist in the fiber aggregation 2b, and they are entangled with other constituent fibers or to the support 3b. In the present embodiment, a reason why there are comparatively long fiber ends 21b having a protrusion length from the fiber aggregation 2b of 10 mm or more is an adoption of such a fiber-raising treatment by pulling the constituent fibers out from the fiber aggregation. If a fiber-raising treatment using rollers having many needles on the peripheral surface thereof (counter pile rollers), as described in Patent Literature 1 and 2, is used, many of the constituent fibers caught by the needles are not pulled out but are cut, as described in these Patent Literatures, and thus it is difficult to obtain a protrusion length of 10 mm or more. In FIG. 14, the long fiber ends 21b are drawn so that they extend from one surface 1ab of

the cleaning sheet 1B in a direction almost intersecting the surface 1ab and stand up, but actually, the long fiber ends 21b are not necessarily formed into the state shown in FIG. 14 prior to be used. For example, there is a case in which they lay almost along the surface 1ab in the more outward position than the straight line BLb, or there is a case in which they extend almost in one direction without crimping, or they are in a crimped state.

[0080]

The straight line BLb is, as described above, a straight line joining contours of the one surface (fiber-raising treatment surface) 1ab of the cleaning sheet 1B. When the surface 1ab is a flat surface without protrusions and recesses, the line BLb agrees with a contour line of the flat surface, and also agrees with a bend line 90Lb (see FIG. 15) when a measurement sample (cleaning sheet) is mountain-folded in a method of measuring a protrusion length from the fiber aggregation of a fiber end. When the surface 1ab is, as shown in FIG. 12 to FIG. 14, an uneven surface having protrusions and recesses, the line BLb does not agree with the contour line of the uneven surface, and definition is necessary separately. In the present invention, when the surface 1ab is the uneven surface, a tangent on an apex part of a protrusion forming the protrusions and recesses is defined as the straight line BLb, and when the heights of multiple protrusions forming the protrusions and recesses are different from each other, a tangent on an apex part of a protrusion having the highest height is defined as the straight line BLb. The straight line BLb can be determined by observation of a side surface (or a cross-section along a thickness direction) of the cleaning sheet 1B with an optical microscope.

[0081]

The cleaning sheet 1B has a certain catching property and the holding property to hair and garbage such as dust, due to the existence of the surface (the fiber-raising treatment surface) 1ab having long fiber ends 21b, the garbage-catching property and the garbage-holding property are further improved due to 10 mm or more of the protrusion length from the fiber aggregation 2b of the long fiber ends 21b, and the excellent garbage-catching property and garbage-holding property can be exerted in not only a case in which the surface to be cleaned such as a floor is dry (or the garbage to be caught is dry) but also a case in which the surface to be cleaned is wet with water or the like (or the garbage to be caught is wet). When the protrusion length is less than 10

mm, the garbage-catching property or the garbage-holding property is insufficient, and in particular when the surface to be cleaned or the garbage is wet, the garbage-catching property or the garbage-holding property is insufficient. In order to definitely exert such effects caused by the long fiber ends 21b, a protrusion length of the long fiber end 21b is preferably 10 mm or more, and preferably 30 mm or less, more preferably 25 mm or less. For more details, the protrusion length is preferably from 10 to 30 mm, more preferably from 10 to 25 mm. When the protrusion length is too long, the all constituent fibers are easily dropped off from the fiber aggregation 2b, the long fiber ends 21b may not possibly exist. The protrusion length from the fiber aggregation of the fiber end is measured as follows.

[0082]

<Method of Measuring Length of Fiber End (Protrusion Length from Fiber Aggregation)>

FIG. 15 is the explanatory view of the method of measuring the length of the fiber end. A sheet having a fiber-raising treatment surface to be measured is cut into a 20 cm × 20 cm measurement sample 90b, and the measurement sample 90b is mountain-folded at a bend line 90Lb of a straight line in a state in a fiber-raising treatment surface side is made face outward, which is put on an A4-sized black pasteboard 91b while the state mountain-folded is maintained. In FIG. 15, a symbol 90Ab shows one end part of the measurement sample 90b mountain-folded on the pasteboard 91b side, and a symbol 90Bb is the other end part of the measurement sample 90b. The folding direction when the measurement sample 90b is mountain-folded is not particularly limited, and it may be an MD (a machine direction) of the measurement sample 90b or may be CD (a cross machine direction) orthogonal to MD. The direction is usually MD. "The folding direction is set at MD" means that the measurement sample 90b is folded so that an extending direction of the bend line 90Lb agrees with CD (a direction orthogonal to MD). A double sided tape 92b is pasted along the bend line 90Lb on the whole area of a range from the bend line 90Lb to 30 mm outward from a direction orthogonal to the bend line 90Lb (a longitudinal direction of the pasteboard 91b) in the pasteboard 91b on which the measurement sample 90b is put (so that the double sided tape 92b is not overlaid with the bend line 90Lb). A length L92b of the double sided tape 92b in a direction along the bend line 90Lb is set at 10 cm. A rectangular area (a part with a diagonal line in FIG. 15), in a

plan view, having an area of 10 cm^2 from the bend line 90Lb (side edge in a longitudinal direction on the bend line 90Lb side of the double sided tape 92b) to 10 mm inward in the longitudinal direction of the pasteboard 91b in the measurement sample 90b put on the pasteboard 91b is defined as an area to be measured 93b. The area to be measured 93b is stroked with a brush [a brush NO. 812 for general use manufactured by KOMERI Co., Ltd, a brush width (a width of an entire part where hair is disposed in the brush) of 30 mm], and it is bonded to the double sided tape 92b in a state in which the fiber ends 94b of the constituent fibers of the measurement sample 90b in the area to be measured 93b are stretched in a straight line in a direction orthogonal to the bend line 90Lb. This stroking in the area to be measured 93b with the brush is performed in a manner in which the brush is moved ten times in a direction orthogonal to the bend line 90Lb from the inward side toward the outward side (to the double sided tape 92b) of the measurement sample 90b, and a force applied to the area to be measured 93b (stroking force) is adjusted to a range of 5 to 15 gf during the stroking with the brush. The stroking force can be measured using a balance, and it can be controlled referring to the measured values. In this way, as shown in FIG. 15, a perpendicular line of each fiber end 94b bonded to the double sided tape 92b in the state in which it is stretched in the direction orthogonal to the bend line 90Lb, the perpendicular line extending from the free end of the fiber end 94b to the straight line BLb [a straight line joining the contours of the fiber-raising treatment surface of the measurement sample 90b in a side view of the measurement sample 90b (the cleaning sheet)], is drawn; and the length of the perpendicular line is defined as the protrusion length L0b from the fiber aggregation of the fiber end 94b (see FIG. 15). The straight line BLb is as described above, and when the fiber-raising treatment surface of the measurement sample 90b is a flat surface without protrusions and recesses, the straight line BLb agrees with the bend line 90. A protrusion length L0b of each fiber end 94b is measured in the procedures described above at arbitrary three points in the area to be measured 93b per measurement sample 90b, and the maximum value in the multiple values L0b is defined as the protrusion length from the fiber aggregation of the fiber end in the measurement sample 90b.

[0083]

The number of the long fiber ends 21b having a protrusion length from the fiber aggregation 2b of 10 mm or more are preferably 10 or more, more preferably from 10 to 60 per 10 cm^2 of the fiber-raising treatment surface (per rectangular area to be

measured 93b in a plan view shown in FIG. 15) in any position in the fiber-raising treatment surface 1ab, in order to definitely improve the garbage-catching property and the garbage-holding property. The number of long fiber ends in the cleaning sheet 1B is, accordingly, preferably 10 or more. The number of the long fiber ends corresponds to the number of the fiber ends having a protrusion length L0b of 10 mm or more among the multiple fiber ends 94b bonded to the double sided tape 92b in the method of measuring the protrusion length described above (see FIG. 15). Specifically, the number of fiber ends 94b having a protrusion length L0b of 10 mm or more (i. e., the long fiber ends) is counted in each of the three arbitrary points in the area to be measured 93b per measurement sample 90b, and the average value thereof is defined as the number of the long fiber ends in the measurement sample 90b.

[0084]

In the present embodiment, as shown in FIG. 12 and FIG. 13, the cleaning sheet 1B having long fiber ends 21b has the unevenness including protrusions 11b and recesses 12b on one surface (the fiber-raising treatment surface) 1ab. More specifically, the cleaning sheet 1B has the surface 1ab and the other surface 1bb which is located on the opposite side thereto, and has many protrusions 11b which are formed so that the protrusions protrude from the other surface 1bb side to the one surface 1ab side. The recess 12b is formed between the adjacent protrusions 11b and 11b, and the sheet has an uneven shape formed from many protrusions 11b and the recesses 12b. The unevenness is provided to the sheet surface as described above, and thus garbage can be caught and held by the unevenness by itself. At the same time, in a fiber-raising treatment of the sheet by contact of a fiber-raising processing roll with a sheet to be subjected to the fiber-raising processing in a fiber-raising processing apparatus described below, the protrusions 11b forming the unevenness more efficiently come into contact with the peripheral surface of the fiber-raising processing roll compared to a case in which the sheet surface is a flat surface without protrusions and recesses, and thus the constituent fibers of the sheet are easily pulled out therefrom, the long fiber ends 21b are easily obtained, and the effects caused by the long fiber ends 21b can be more definitely exerted.

[0085]

In the present embodiment, the number of the long fiber ends 21b is larger on

the protrusion 11b than in the recess 12b. For more details, the number of the long fiber ends 21b having a protrusion length from the fiber aggregation 2b of 10 mm or more is comparatively larger at the apex part of the protrusion 11b and in the vicinity thereof, and is comparatively smaller at the bottom part of the recess 12b and in the vicinity thereof. In this connection, the protrusion length from the fiber aggregation 2b of the fiber end of the constituent fiber (the average value of the protrusion lengths of the multiple fiber ends) in the apex part of the protrusion 11b and the vicinity thereof is longer than the protrusion length in the bottom part of the recess 12b and in the vicinity thereof. The reason why the protrusion 11b has more long fiber ends 21b than the recess 12b, and the protrusion length is long, as above, is that the protrusion 11b has more chances to be brought into contact with the fiber-raising processing roll than the recess 12b in the fiber-raising treatment of the uneven surface including the protrusions 11b and the recesses 12b, as described above. The "apex part of the protrusion 11b and in the vicinity thereof" described above corresponds to an "upper layer" when the height h_b (see FIG. 13) of the protrusion 11b is divided into three equal parts and each part is called as a "upper later", a "middle layer" and a "lower layer" from top to bottom, and the "bottom part of the recess 12b and in the vicinity thereof" described above corresponds to the "lower layer."

[0086]

As there are comparatively many long fiber ends 21b on the protrusions 11b and the protrusion length of the fiber end of the recess 12b is comparatively short, as above, the functions of the protrusion 11b and the recess 12b are different from each other, whereby the surface of the cleaning sheet 1B (the uneven surface) 1ab can efficiently catch and hold various garbage pieces as a whole. When the present inventors have performed cleaning test of various garbage pieces using the cleaning sheet having the uneven surface as shown in FIG. 12 and FIG. 13, the results are that a ratio of an amount of sesame seeds, which are used as particulate garbage, held in the recesses to the amount in the protrusions is recess:protrusion = about 5:1, and thus the comparatively large amount of the sesame seeds are held in the recesses, and on the other hand, hair, which is used as fiber garbage, is almost uniformly held on the whole sheet. From the results as above, it can be assumed that the protrusions 11b having a comparatively large number of the long fiber ends 21b catch garbage pieces having various shapes such as fiber and particulate shapes from a surface to be cleaned and, at

the same time, entangle the fiber garbage among them with the long fiber ends 21b to preferentially hold it; the recess 12b having a comparatively small number of long fiber ends 21b take mainly the particulate garbage among the garbage caught through the protrusions 11b; and the long fiber ends 21b extending from the adjacent protrusion 11b hold the particulate garbage.

[0087]

Many protrusions 11b have, as shown in FIG. 12, almost the same size and are mountain-shaped with slightly narrow width, and are regularly formed. An interval between the adjacent protrusions 11b and 11b in the surface 1ab of the cleaning sheet 1B is preferably 1 mm or more, more preferably 2 mm or more, and preferably 10 mm or less, more preferably 8 mm or less, in a width direction of the sheet (a Y direction in FIG. 12, CD in the manufacture of the sheet). For more details, the interval in the width direction of the sheet is preferably from 1 to 10 mm, more preferably from 2 to 8 mm. An interval in a longitudinal direction of the sheet (an X direction in FIG. 12, MD in the manufacture of the sheet) is preferably 3 mm or more, more preferably 4 mm or more, and preferably 20 mm or less, more preferably 15 mm or less. For more details, the interval in the longitudinal direction of the sheet is preferably from 3 to 20 mm, more preferably from 4 to 15 mm. The protrusion 11b may be partly connected to another protrusion in the width direction and/or longitudinal direction of the sheet to form a continuous body, and also they are formed into a continuous body on the whole sheet. When the protrusions 11b are formed with such intervals, the softness of the cleaning sheet 1B can be improved and the surface to be cleaned can be prevented from damage. In addition, the cleaning property to dust in grooves in a wooded floor or on an uneven surface is excellent, and the catching property and holding property to relatively large dust such as bread crumbs are also excellent. Furthermore, the three-dimensional shape of the protrusions 11b becomes clear and the stability of the three-dimensional shape is improved, and thus the unevenness becomes clear and it is difficult to crush the protrusions while the sheet is used.

[0088]

It is preferable that both sides of the cleaning sheet 1B have the same functions, and the shape of the protrusion 11b and the interval between the protrusions 11b on the other surface 1bb are almost the same as those on the surface (the fiber-raising treatment

surface) 1ab. In particular, a total area of the protrusion 11b on the other surface 1bb is preferably 20% or more, more preferably 35% or more, and preferably 100% or less of a total area of the protrusion 11b on the one surface 1ab. For more details, the ratio is preferably from 20 to 100%, more preferably from 35 to 100%. It is preferable that a relationship between the protrusions 11b on the surface 1ab and the recesses 12b on the other surface 1bb of the cleaning sheet 1B is an obverse and reverse relationship, in terms of the garbage-catching and holding properties. It is also preferable that the shape of the protrusion 11b is a reversed shape of the shape of the recess 12b.

[0089]

The protrusions 11b and the recesses 12b are formed from the fiber aggregation 2b, and are formed only by entanglement of the fibers forming the fiber aggregation 2b. For this structure, the protrusions 11b and the recesses 12b are different from protrusions and recesses which are formed by partially subjecting fibers of a thermoplastic resin to a heating and pressurizing processing such as embossing to melt them, and have soft touch. In addition, the degree of freedom of the constituent fibers is high due to the existence in the state in which the constituent fibers are not molten and exist independently, and hair and garbage such as fine dust can be efficiently caught by the whole surface of the sheet, thus resulting in the excellent catching property and holding property.

[0090]

The protrusions 11b and the recesses 12b are, as described below, formed by rearrangement-re-entangling of the constituent fibers by hydroentanglement process, which is subjected to the fiber aggregation 2b, and thus the protrusions 11b and the recesses 12b hold the shapes by themselves. The protrusions 11b and the recesses 12b, accordingly, do not easily lose their strength by a load. "Formed by rearrangement-re-entangling of the fibers" in the present specification means that the fiber aggregation, which has once been weekly entangled by the entangling in stream of water, is entangled in stream of water again on a patterning member having many protrusions and recesses or many openings, whereby the fibers are rearranged along the recesses and the protrusions and entangled again. Due to the formation of the protrusions 11b and the recesses 12b, apparent thickness of the cleaning sheet 1B becomes thicker than the thickness of the fiber aggregation 2b to which the protrusions 11b and the recesses

12b have not been provided yet. The cleaning sheet 1B having the protrusions 11b and the recesses 12b with high shape-retaining property has the excellent cleaning property to grooves and an uneven surface of a surface to be cleaned, and the excellent catching property and holding property to garbage such as bread crumbs.

[0091]

As described above, when the fiber aggregation 2b is subjected to entangling in stream of water on the patterning member again, the constituent fibers located in the recesses of the patterning member, i.e., the constituent fibers located on the protrusions 11b of the cleaning sheet 1B are stretched by the stream of water toward the recesses of the patterning member, and thus the degree of the entangling of constituent fibers is decreased compared to the sheet prior to the patterning. On the other hand, the fibers located on the protrusions of the patterning member, i.e., the constituent fibers located in the recesses 12b of the cleaning sheet 1B are struck by the stream of water toward the protrusions of the patterning member, and thus the degree of the entangling of constituent fibers is increased compared to the sheet prior to the patterning. As a result, in the cleaning sheet 1B, the structure of the entangling of the constituent fibers in the protrusions 11b is weaker than that in the recesses 12b. For this structure, the cleaning property to grooves or an uneven surface in a surface to be cleaned is excellent, and the catching property and holding property to garbage such as bread crumbs are excellent, and furthermore, hair and dust can be efficiently entangled because the fibers forming the protrusions 11b, which have comparatively weak entangling, are strongly brought into contact with a floor surface. In addition, the fibers forming the recesses 12b have comparatively strong entangling, and thus dropping-off of the constituent fibers can be prevented in the cleaning.

[0092]

When the entangling of the constituent fibers in the protrusions 11b are weaker than that in the recesses 12b as above, and the number of the chances in which the protrusions 11b are brought into contact with the fiber-raising processing roll is larger than the chance in the recesses 12b in the fiber-raising treatment of the uneven surface including the protrusions 11b and the recesses 12b as described above, part of the fiber forming the protrusion 11b (the apex part of the protrusion 11b and in the vicinity thereof) are easily pulled out by the fiber-raising processing roll, and many long fiber

ends 21b exist on the protrusion 11b.

[0093]

It is preferable that there are preferably 50 or more, more preferably 100 or more, and preferably 850 or less, more preferably 600 or less, on average, of the protrusions 11b in a range of 10 cm $\times$ 10 cm of the surface (fiber-raising treatment surface) 1ab or the other surface 1bb of the cleaning sheet 1B in any surface of the two. For more details, preferably from 50 to 850, more preferably from 100 to 600 of the protrusions are formed. When the protrusions 11b are partly continued to form a continuous body, or are formed into a continuous body on the whole sheet in the width direction and/or the longitudinal direction of the sheet, preferably 10 lines or more, more preferably 20 lines or more, and preferably 50 lines or less, more preferably 40 lines or less, on average, of the protrusions are formed, in a range of a length of 10 cm in the width direction and/or the longitudinal direction of the sheet. For more details, it is preferably that 10 to 50 lines, more preferably 20 to 40 lines, are formed. When the number of the protrusion 11b is adjusted to the range described above, arrangement of the protrusions 11b and the recesses 12b is well-balanced, and thus the catching property and the holding property to fine garbage are further improved, and the catching property and the holding property to comparatively large garbage such as bread crumbs are also further improved.

[0094]

In the cleaning sheet 1B, as shown in FIG. 13, the apparent thickness [the thickness between the uppermost part (provided that the long fiber end 21b is excluded) of the surface (fiber-raising treatment surface) 1ab and the lowermost part of the other surface 1bb] T_b is thicker than the thickness of the fiber aggregation 2b itself [the thickness between the lowermost part of the support 3b and the uppermost part (provided that the long fiber end 21b is excluded) of the surface (fiber-raising treatment surface) 1ab] t_b , and thus the cleaning sheet is in a bulky state. An apparent thickness T_b of the cleaning sheet 1B itself is preferably 1 mm or more, more preferably 1.3 mm or more, and preferably 5 mm or less, more preferably 4 mm or less. For more details, it is preferable that the thickness T_b is from 1 to 5 mm, more preferably from 1.3 to 4 mm, because sufficient spaces are formed in the cleaning sheet 1B to become bulky, and it can be preferably used as the cleaning sheet. A thickness t_b of the fiber aggregation

2b itself depends on the basis weight of the fiber aggregation 2b and the processing condition, and is preferably 0.2 mm or more, more preferably 0.5 mm or more, and preferably 4 mm or less, more preferably 3 mm or less. For more details, the thickness tb is preferably from 0.2 to 4 mm, more preferably from 0.5 to 3 mm. As shown in FIG. 13, a height hb of the protrusion 11b is preferably 0.2 mm or more, more preferably 0.5 mm or more, and preferably 4 mm or less. For more details, the height hb is preferably from 0.2 to 4 mm, more preferably from 0.5 to 4 mm. The apparent thickness Tb of the cleaning sheet 1B, the thickness tb of the fiber aggregation 2b itself, and the height hb of the protrusion 11b are measured in a manner in which a weight on a 10 cm × 5 cm acrylic plate having a total weight of 30 g is put on a cleaning sheet 1B having a fiber aggregation 2b to be measured, a load of $30 \text{ gf}/50 \text{ cm}^2 = (59 \text{ Pa})$ is applied to the cleaning sheet 1B in a thickness direction, and a cross-section of the cleaning sheet 1B is observed with an optical microscope while keeping the above state.

[0095]

The fiber aggregation 2b is further explained. As described above, the fiber aggregation 2b in the present embodiment is the spun lace non-woven fabric formed by entangling the fiber web in stream of water, and is formed only by entangling of the constituent fibers, but the fiber aggregation in the present invention may partly include parts formed by melting or bonding of the constituent fibers so long as it includes a part formed by the entangling of the constituent fibers. However, for easily obtaining fibers raised having a length of raised part of 10 mm or more by a fiber-raising treatment using a fiber-raising processing roll, the fiber aggregation in the present invention having a high degree of freedom of the constituent fibers are preferable; specifically, aggregations formed only by entangling the constituent fibers such as the spun lace non-woven fabric are preferably used. In addition to the spun lace non-woven fabric, needle punch non-woven fabrics and stitch bonding non-woven fabrics are also preferably used as the fiber aggregation in the present invention, because of a high degree of freedom of constituent fibers. In particular, the spun lace non-woven fabric is preferable because of the excellent catching property to garbage.

[0096]

Various fibers usually used as a fiber forming a non-woven fabric may be used as the fiber forming the fiber aggregation 2b (the long fiber end 21b), and examples

thereof may include polyolefins such as polyethylene (PE) and polypropylene (PP); polyesters such as polyethylene terephthalate (PET) and polybutylene terephthalate (PBT); synthetic fibers (thermoplastic fibers) made of a synthetic resin such as polyamide, including Nylon (a registered trademark) and nylon 6; regenerated cellulosic fibers such as rayon, biodegradable fibers such as polylactic acid, and the like. The fiber composition of the constituent fiber may be a monofilament including one kind of a resin, or a conjugated fiber including two or more kinds of resins whose melting points are different from others. The conjugated fiber may include core-sheath conjugated fibers having a sheath part formed of a resin with a relatively low melting point (a low melting point resin) and a core part formed of a resin with a relatively high melting point (a high melting point resin); side-by-side conjugated fibers in which a low melting point resin and a high melting point resin are arranged in a line in a predetermined direction, and the like.

[0097]

In the fiber aggregation 2b, a ratio of the number of constituent fibers having a fiber size (a diameter) of 5 to 60 μm (hereinafter which may also be referred to as a specific fiber) to the number of all constituent fibers is preferably 50% by mass or more, more preferably 70% by mass or more, even more preferably 100% by mass, in terms of the garbage-catching property and the garbage-holding property. The specific fiber has the lower limit of the fiber size of preferably 8 μm , more preferably 10 μm , for reducing the frictional resistance when the surface to be cleaned is wiped. The upper limit thereof is preferably 45 μm , more preferably 40 μm , in terms of the prevention of the dropping-off of the fibers and catching property to fine garbage. When the fiber size of the fibers (the specific fibers described above) forming the fiber aggregation 2b is within the range described above, the fiber size of the long fiber end 21b is within the range described above. The fiber size of the constituent fiber is measured as follows:

[0098]

<Method of Measuring Fiber Size>

Arbitrary ten fiber sizes (diameter) of a fiber to be measured (a fiber forming the fiber aggregation) are measured using a microscope, the average value of the 10 measurement values is defined as the fiber size of the fiber. When the fiber aggregation includes two or more kinds of fibers whose fiber sizes are different from

others, arbitrary 10 fiber sizes of each fiber are measured according to the procedures described above, and the average value of the ten measurement values is defined as the fiber size of each fiber. When a cross-section of the fiber is not a perfect circle but an ellipse or a flat structure (when the object to be measured is a non-perfect circle fiber), an equivalent diameter is simply obtained according to the following method, and the diameter is defined as the fiber size of the non-perfect circle fiber. Ten parts which are relatively thick and ten parts which are relatively thin are arbitrarily selected from the non-perfect circle fiber, a fiber size (a diameter) of each of the 20 parts is measured using a microscope, the square root of the product of a, which is the average value of the ten thick parts, and b, which is the average value of the ten thin parts, is defined as the fiber size of the non-perfect circle fiber.

[0099]

A fiber length of the fibers forming the fiber aggregation 2b is preferably 25 mm or more, more preferably 35 mm or more, and preferably 100 mm or less, more preferably 70 mm or less, in order to obtain a length of the fiber end (a protrusion length from the fiber aggregation 2b) of 10 mm or more when the fiber ends of the constituent fibers are pulled out from the fiber aggregation 2b by the fiber-raising treatment described below, and to maintain the strength sufficient for practical use as the cleaning sheet after the fiber-raising treatment. For more details, the fiber length is preferably from 25 to 100 mm, more preferably from 35 to 70 mm. The fiber length is measured as follows: Ten constituent fibers are pulled out from the fiber aggregation to be measured with careful attention that the constituent fibers is not cut, a length of each fiber pulled out is measured, and the average value of them is defined as the fiber length of the fibers forming the fiber aggregation. When the fibers pulled out are crimped, the length is measured in the state in which the fibers are straightly stretched.

[0100]

A basis weight of the fiber aggregation 2b is preferably 15 g/m^2 or more, more preferably 20 g/m^2 or more, and preferably 100 g/m^2 or less, more preferably 80 g/m^2 or less. For more details, the basis weight is preferably from 15 to 100 g/m^2 , more preferably 20 to 80 g/m^2 , because it can be prevented that garbage goes through the sheet 1B to its reverse or that a hand holding the sheet 1B is stained when the cleaning sheet 1B is used, and the fibers forming the fiber aggregation 2b can be sufficiently

entangled with each other and the fiber aggregation 2b can be sufficiently entangled with the support 3b.

[0101]

In the present embodiment, the support 3b includes a mesh sheet to which the fibers forming the fiber aggregation 2b can be entangled, and specifically, as shown in FIG. 16, a latticed net 31 having many holes 30b. As the support 3b exists continuously in a direction of the plan view of the cleaning sheet 1B, even if the fiber aggregation 2b has a low basis weight and has weak entangling, and thus the strength is slightly insufficient, the strength sufficient for practical use can be provided to the sheet as a whole of the cleaning sheet 1B by using the mesh sheet as the support 3b. In order to stably perform the pulling-out of the constituent fibers in the fiber-raising treatment, it is preferable that the degree of freedom of the constituent fibers is made as higher as possible and that the entangling of the constituent fibers in the fiber aggregation 2b is weaker. In general, when the entangling of the fibers is weak, the strength of the cleaning sheet 1B is decreased, and it is difficult to provide the strength sufficient for practical use. When the support 3b is used, however, the sufficient strength can be provided to the cleaning sheet, and thus even if the entangling of the fiber aggregation 2b is weak, the strength of the cleaning sheet does not become weak to such an extent that it is difficult to use the sheet. As a result, the fibers can be effectively pulled out in the fiber-raising treatment without cutting of the fibers, and the cleaning sheet 1B having the sufficient strength can be obtained.

[0102]

Each size of the wire diameter L1b of the net 31 and distance L2b between the wires is appropriately determined considering the entangling to the fiber aggregation 2b, and the like. The wire diameter L1b corresponds to a thickness of the net 31b. The wire diameter L1b is preferably 50 μm or more, more preferably 100 μm or more, and preferably 600 μm or less, more preferably 400 μm or less. For more details, the wire diameter L1b is preferably from 50 to 600 μm , more preferably from 100 to 400 μm . The distance L2b between the wires is preferably 2 mm or more, more preferably 4 mm or more, and preferably 30 mm or less, more preferably 20 mm or less. For more details, the distance L2b is preferably from 2 to 30 mm, more preferably from 4 to 20 mm. The wire diameter L1b may be partly different from other parts, and in such a

case, the wire diameter of a relatively thick part corresponds to the value described above. The distance L2b between the wires in the width direction of the sheet (Y direction in FIG. 16, CD in the manufacture of the sheet) may be the same as or different from that in the longitudinal direction of the sheet (X direction in FIG. 16, MD in the manufacture of the sheet).

[0103]

The support (the mesh sheet) in the present invention is not limited to the latticed net 31b, and may be, for example, a perforated film 32b having many holes 30b, as shown in FIG. 17(a) to FIG. 17(c). The kind of the mesh sheet, therefore, is not particularly limited so long as it is a support which has holes through which the fibers can be passed and to which the fiber aggregation or the fiber web, which is a material forming it, can be integrated in the entangled state. For example, a loose woven fabric having a comparatively large space between threads such as gauze; a non-woven fabric or paper having spaces between fibers capable of overlaying fiber web on one side or both sides thereof and integrating it in the entangled state; various non-woven fabrics or paper having openings may be used as the mesh sheet of the support 3b. In FIG. 16 and FIG. 17, the shape of the hole 30b in a plan view can be appropriately changed. For example, the shape in the perforated film 32b may be a star shape (a cross shape) as shown in FIG. 17(a), or a circle as shown in FIG. 17(b). In addition, as shown in FIG. 17(c), the shape may be a combination of holes 30b of multiple kinds of shapes in a plan view (two kinds of a star shape and a circle in the state shown in the drawing).

[0104]

The material forming the support 3b (the mesh sheet) may include, for example, polyolefin resins such as polyethylene, polypropylene, and polybutene; polyester resins such as polyethylene terephthalate and polybutylene terephthalate; polyamide resins such as nylon 6 and nylon 66; acrylonitrile resins; vinyl resins such as polyvinyl chloride; vinylidene resins such as polyvinylidene chloride; cellulose regenerated fibers such as rayon; pulp materials, and the like. In addition, modified products of the forming material, alloy, and mixtures thereof may also be used.

[0105]

A basis weight of the support 3b (the mesh sheet) is preferably 3 g/m² or more, more preferably 4 g/m² or more, and preferably 60 g/m² or less, more preferably 40 g/m² or less. For more details, the basis weight is preferably from 3 to 60 g/m², more preferably from 4 to 40 g/m². A mass ratio of the support 3b to the whole cleaning sheet 1B is preferably 5% by mass or more, more preferably 8% by mass or more, and preferably 70% by mass or less, more preferably 60% by mass or less. For more details, the mass ratio is preferably from 5 to 70% by mass, more preferably from 8 to 60% by mass.

[0106]

A sheet elongation of the support 3b (the mesh sheet) is preferably less than 40%, more preferably less than 20%, even more preferably less than 10%, in order to improve the attaching property of the cleaning sheet 1B to the cleaning tool, to prevent deterioration of operability such as dropping-off from a cleaning tool by elongation of the cleaning sheet 1B during the cleaning, and to stably subject the cleaning sheet 1B to the fiber-raising treatment.

[0107]

A basis weight of the cleaning sheet 1B is preferably 35 g/m² or more, more preferably 45 g/m² or more, and preferably 150 g/m² or less, more preferably 100 g/m² or less. For more details, the basis weight is preferably from 35 to 150 g/m², more preferably from 45 to 100 g/m², for providing an appropriate thick feeling to the cleaning sheet 1B and to improve the processing suitability.

[0108]

The cleaning sheet 1B has an entangling coefficient expressed by an initial gradient of a stress-strain curve in a direction vertical to a fiber orientation in the fiber aggregation 2b forming the cleaning sheet 1B of preferably 0.05 N·m/g or more, more preferably 0.2 N·m/g or more, and more preferably 2 N·m/g or less, more preferably 1.2 N·m/g or less. For more details, the entangling coefficient is preferably from 0.05 to 2 N·m/g, more preferably from 0.2 to 1.2 N·m/g, because the sufficient entangling can be performed, and the degree of freedom of the fibers sufficient for catching garbage can be obtained. It can be said that the weaker the entangling between the fibers, the

smaller the values of the entangling coefficient. The stress shows a value obtained by dividing a tensile load by a held width (a width of a specimen when the tensile strength is measured) and a basis weight of the nonwoven-fabric-like fiber aggregation 2b, and the strain shows an elongation. The degree of the entangling between the fibers mainly depends on the entangling energy which is applied to the fiber web in the entangling treatment. For example, in the entangling in stream of water (water-needling), the entangling energy added to the fiber web can be controlled by conditions such as the kind of the fiber, the basis weight of the fiber web, the number of the water jet nozzles and the water pressure therein, and the line speed.

[0109]

Next, one example of a method for manufacturing the cleaning sheet 1B of the present embodiment is explained with reference to FIG. 18 and FIG. 19. The method for manufacturing the cleaning sheet 1B of the present embodiment includes an overlaying step in which an upper layer fiber web 4ab and a lower layer fiber web 4bb are overlaid on both surfaces of a support 3b (a net 31b) to form an overlaid product 5b; an entangling step in which the constituent fibers in the fiber webs 4ab and 4b in the overlaid product 5b are entangled with each other to form fiber aggregations 2b and, at the same time, the constituent fibers are entangled with the support 3b by the entangling in stream of water to form a composite 6b in which the two components are integrated; an unevenness-providing step in which the composite 6b is carried to a patterning member having many protrusions and recesses, and a part of the fiber aggregation 2b is pushed into the recesses to provide many protrusions 11b (see FIG. 12 and FIG. 13) corresponding to the recesses on the composite 6b, thereby obtaining an uneven composite 7b; a drying step in which the uneven composite 7b is dried; and a fiber-raising step in which the uneven composite 7b is subjected to a fiber-raising treatment, the steps proceeding in this order. An arrow shown by a symbol X in FIG. 18, and an arrow shown by a symbol V1b in FIG. 19 show MD (a machine direction) during the manufacture of the cleaning sheet 1B.

[0110]

A manufacturing apparatus 50b includes, as shown in FIG. 18, an overlaying section 50Ab, and entangling section 50Bb, and an unevenness-providing section 50Cb. The overlaying section 50Ab includes carding machines 51Ab and 51Bb which

manufacture fiber webs 4ab and 4bb respectively, sending-out rolls 52b and 52b for the fiber webs 4ab and 4bb, and a sending-out roll 54b for a support 3b (a net 31b) which is wound in the state of roll. The entangling section 50Bb includes a web-supporting belt 55b formed of an endless belt and a first water jet nozzle 56b. The unevenness-providing section 50Cb includes a patterning member 57b formed of an endless belt and a second water jet nozzle 58b. The patterning member 57b is rotated in a direction of an arrow in FIG. 18. The patterning member 57b is liquid-permeable, and has many protrusions and recesses on its surface.

[0111]

The manufacturing apparatus 50b also includes, as shown in FIG. 19, a fiber-raising processing section 50Db. The fiber-raising processing section 50Db is a section in which the fibers forming the uneven composite 7b, which has been passed through the unevenness-providing step, are raised, and the manufacturing apparatus 50b of the present embodiment includes a fiber-raising processing roll 60b having many protrusions 60Ab on its peripheral surface. The fiber-raising processing roll 60b is cylindrical and is made of a metal such as aluminum alloy or steel. The fiber-raising processing roll 60b is rotated by transmitting driving force to the axis of rotation from a driving means (not shown in the drawing). A rotating speed (a peripheral velocity $V2b$) of the fiber-raising processing roll 60b is controlled by a control section (not shown in the drawing) provided in the manufacturing apparatus 50b. Here, the peripheral velocity $V2b$ of the fiber-raising processing roll 60b refers to a speed on the surface of the fiber-raising processing roll 60b. A raising height of the fiber raised (a standing height of the long fiber end 21b) and the number of the fibers raised (the number of the long fiber ends) can be adjusted by controlling the peripheral velocity $V2b$ of the fiber-raising processing roll 60b.

[0112]

Each protrusion 60Ab on the peripheral surface of the fiber-raising processing roll 60b has a height, which is from the peripheral surface to the top (the tip of an apex part) of the protrusion 60Ab, of preferably 0.01 mm or more, and preferably 5 mm or less, more preferably 2 mm or less. For more details, the height is preferably from 0.01 to 5 mm, more preferably from 0.01 to 2 mm. A distance (a pitch) between the protrusions 60Ab adjacent in the circumferential direction, and a distance (a pitch)

between the protrusions 60Ab adjacent in the direction of the axis of rotation are preferably 0.01 mm or more, and preferably 60 mm or less, more preferably 5 mm or less. For more details, the distances are preferably from 0.01 to 60 mm, more preferably from 0.01 to 5 mm. It is preferable that the number of the protrusions 60Ab per unit area is from 50 to 5000/cm², because the fiber-raising can be effectively performed. A shape of the apex part of the protrusion 60Ab in a plan view is not particularly limited, and examples thereof may include a circle, an ellipse, a polygon, and the like. An area of the tip of the apex part of the protrusion 60Ab is preferably 0.001 mm², and preferably 10 mm² or less, more preferably 1 mm² or less for improving the ease of catching of the fibers, and for performing efficient fiber-raising. For more details, the area is preferably from 0.001 to 10 mm², more preferably from 0.001 to 1 mm². The roll having the uneven surface including such protrusions 60Ab may include, in addition to an embossing roll having a fine uneven pattern on its peripheral surface, a roll having sandpaper wound around the peripheral surface, a roll having the peripheral surface to which the unevenness-providing processing is applied by sandblast (a sandblasted roll), and the like.

[0113]

The fiber-raising processing section 50Db includes, as shown in FIG. 19, carrying rolls 61b and 62b, which are provided on the upstream side and the downstream side of the fiber-raising processing roll 60b, respectively, and carry an object to be subjected to fiber-raising processing (an uneven composite 7b). The carrying speed V1b of the uneven composite 7b is controlled by a control section (not shown in the drawing) provided in the manufacturing apparatus 50b. Here, the carrying speed V1b of the uneven composite 7b refers to a speed on the surface of the uneven composite 7b supplied to the fiber-raising processing roll 60b.

[0114]

In order to further effectively raise the fibers forming the uneven composite 7b, as shown in FIG. 19, it is preferable that the position of the carrying roll 61b located on the downstream side of the fiber-raising processing roll 60b, is set higher than the position of the fiber-raising processing roll 60b. For more details, the uneven composite 7b is brought into contact with a contact surface (a peripheral surface) of the fiber-raising processing roll 60b at a jamb angle α of preferably 10° or more, more

preferably 30° or more, and preferably 180° or less, more preferably 120° or less. For more details, the composite 7b is brought into contact at a jamb angle of preferably 10 to 180° , more preferably 30 to 120° .

[0115]

In the manufacturing apparatus 50b of the cleaning sheet 1B having such a structure, first, as shown in FIG. 18, the fiber webs 4ab and 4bb are continuously sent out from the carding machines 51Ab and 51Bb in the overlaying section 50Ab through the sending-out rolls 52b and 52b, respectively, and at the same time the rolled support 3b (net 31b) is sent out from the sending-out roll 54b. Then, the fiber webs 4ab and 4bb are overlaid on both surfaces of the net 31b through the sending-out rolls 52b and 52b to form an overlaid product 5b (the overlaying step).

[0116]

Next, in the entangling section 50Bb, as shown in FIG. 18, the overlaid product 5b is subjected to the entangling with high pressure jet stream of water jetted from the first water jet nozzle 56b, while it is moved and carried to the web-supporting belt 55b (the entangling step). In this manner, the constituent fibers of the fiber webs 4ab and 4bb in the overlaid product 5b are entangled with each other to form a fiber aggregation 2b and at the same time the constituent fibers are entangled with the support 3b, thereby obtaining a composite 6b in which the three components are entangled.

[0117]

Next, in the unevenness-providing section 50Cb, as shown in FIG. 18, a pressure is applied to the composite 6b by high pressure jet stream of water jetted from the second water jet nozzle 58b, while it is moved and carried to the patterning member 57b (the unevenness-providing step). At that time, parts of the composite 6b located in the recesses of the patterning member 57b is pressurized, and the pressurized parts are pushed into the recesses. As a result, the pressurized parts turn into recesses 12b corresponding to the recesses (see FIG. 12 and FIG. 13). On the other hand, parts of the composite 6b located on the protrusions of the patterning member 57b are not pushed but turn into protrusions 11b. In this manner, the many protrusions 11b and recesses 12b are formed on the composite 6b, and an uneven composite 7b in which the

uneven shape is provided to the whole composite 6b is obtained. The many protrusions 11b and recesses 12b are formed on the uneven composite 7b, but the net 31b, which is the support 3b, does not have an uneven shape. The shape of the protrusion 11b on the uneven composite 7b is determined according to the kind of the patterning member 57b, or an entangling energy applied to the fiber aggregation, generated by a high pressure jet stream of water, in the entangling section 50Bb and the unevenness-providing section 50Cb. This entangling energy is controlled by conditions such as a nozzle shape of the water jet nozzle, a nozzle pitch, a water pressure, the number of the nozzles, and a line speed. The unevenness-providing step is a step in which the high pressure jet stream of water is applied to the fiber aggregation (the fiber web) and the support, as the entangling step, and thus the entangling thereof may sometimes also be performed in the unevenness-providing step, and the entangling is not necessarily completed in the entangling step.

[0118]

The thus obtained uneven composite 7b is carried to a heating apparatus (not shown in the drawing) by a carrying belt 29b, and the composite is subjected to a heat treatment such as hot air-blowing to dry it (the drying step). As in the subsequent fiber-raising step, one surface 1ab' (see FIG. 19) of the uneven composite 7b is subjected to the fiber-raising treatment, and it is desirable that the support 3b is not exposed from the surface 1ab', which has not subjected to the fiber-raising treatment yet.

[0119]

Next, in the fiber-raising processing section 50Db, as shown in FIG. 19, the uneven composite 7b is carried on the peripheral surface of the fiber-raising processing roll 60b in a direction Y by the carrying rolls 61b and 62b, and the surface 1ab' of the uneven composite 7b is subjected to the fiber-raising treatment by the fine protrusions and recesses of the peripheral surface (the fiber-raising step). In the fiber-raising processing section 50Db, the uneven composite 7b is carried while it is brought into contact with the peripheral surface of the fiber-raising processing roll 60b, whereby the fibers forming the uneven composite 7b are entangled with the protrusions 60Ab forming the fine protrusions and recesses on the peripheral surface, and the constituent fibers entangled with the protrusions are partly pulled out from the uneven composite 7b, i.e., the constituent fibers are not completely pulled out (do not removed from the

uneven composite 7b), as a result, the fiber ends of the constituent fibers protrude from the surface 1ab' of the uneven composite 7b, and many long fiber ends 21b including the fiber ends (see FIG. 14) are generated. The end parts of the constituent fiber located on the opposite side to the fiber ends (long fiber ends 21b) still remain in the uneven composite 7b. The many protrusions 60Ab on the peripheral surface of the fiber-raising processing roll 60b have a shorter protrusion length from the peripheral surface and a large number of protrusions per unit area compared to many needles on the peripheral surface of a counter pile roller described in Patent Literatures 1 and 2, and thus it is difficult to cut the constituent fiber entangled in the fiber-raising treatment of the fiber aggregation (non-woven fabric), and the constituent fibers are easily partly pulled off from the fiber aggregation without cutting the constituent fibers. In the fiber-raising processing section 50Db, in order to promote the pulling out of the constituent fibers, and to effectively form the long fiber ends 21b, as shown in FIG. 19, it is preferable that the fiber-raising processing roll 60b is rotated in a rotation direction opposite to the carrying direction of the uneven composite 7b. In this manner, the cleaning sheet 1B can be obtained which has fiber-raising treatment surface 1ab on which many long fiber ends 21b having a protrusion length from the fiber aggregation 2b of 10 mm or more are formed.

[0120]

The present invention is not limited to the embodiment described above. For example, in the cleaning sheet 1B, the other surface 1bb located on the opposite side of the surface 1ab may also be the fiber-raising treatment surface having the long fiber ends 21b, not limited to the one surface 1ab. When both sides 1ab and 1bb of the cleaning sheet 1B are the fiber-raising treatment surfaces as above, the manufacturing apparatus 50b may have two fiber-raising processing sections having the same structure as that of the fiber-raising processing section 50Db shown in FIG. 19 in MD (a carrying direction of the uneven composite 7b), and may be formed so that both surfaces of the sheet are sequentially subjected to the fiber-raising treatment by sequentially passing the uneven composite 7b through the fiber-raising processing sections. Alternatively, the structure of the manufacturing apparatus 50b is not changed, and the uneven composite 7b is reversed using one fiber-raising processing section 50Db, whereby the two surfaces can be subsequently subjected to the fiber-raising treatment.

[0121]

In the embodiment described above, in the entangling step, the entangling treatment is performed by applying the high pressure jet stream of water to one surface of the overlaid product 5b, but the entangling treatment may be performed by applying the jet stream of water to both surfaces of the overlaid product 5b simultaneously or subsequently. In addition, the surface 1ab of the cleaning sheet 1B having the long fiber ends 21b may not be uneven.

[0122]

With respect to the embodiment described above, the following composite sheets, manufacturing methods thereof, and cleaning sheets are further disclosed.

[0123]

<1> A composite sheet comprising a nonwoven-fabric-like fiber aggregation, and a mesh sheet or a thermally bonded non-woven fabric as a framework material, the fiber aggregation is integrated to one or both sides of the mesh sheet or the thermally bonded non-woven fabric in a state in which fibers forming the fiber aggregation are entangled with each other and with the framework material,

the composite sheet being formed into a three-dimensional uneven shape so as to have a plurality of protrusions and recesses,

the constituent fibers of the fiber aggregation being raised from the surfaces of the protrusions and the recesses, and

a ratio of a number of the constituent fibers which are raised from the surfaces of the recesses and have a height of 1 mm or more to a number of the constituent fibers which are raised from the surfaces of the recesses and have a height of 0.1 mm or more being 25% or more.

[0124]

<2> The composite sheet according to <1> above, wherein a height of constituent fibers raised from surfaces of the recesses is higher than a height of constituent fibers raised from surfaces of the protrusions.

<3> The composite sheet according to <1> or <2> above, wherein the height of the constituent fiber raised in the recess is from 0.5 to 30 mm, and the number of the

constituent fibers raised in the recess is from 5 to 80 fibers/10 mm width.

<4> The composite sheet according to any one of <1> to <3> above, wherein a material forming the framework material has the lowest melting point among the fiber materials forming the composite sheet.

<5> The composite sheet according to any one of <1> to <4> above, wherein the fiber aggregation is formed by mixing two or more kinds of constituent fibers whose diameters differ from others by double or more.

<6> The composite sheet according to any one of <1> to <5> above, which is used for a cleaning sheet.

<7> The composite sheet according to any one of <1> to <6> above, wherein the composite sheet has 50 or more, or 100 or more, of the protrusions in a range of 10 cm × 10 cm square, or 850 or less, or 600 or less, of the protrusions in a range of 10 cm × 10 cm square, or 50 to 850, or 100 to 600 protrusions in a range of 10 cm × 10 cm square.

<8> The composite sheet according to any one of <1> to <7> above, wherein the constituent fibers raised include fibers raised in the state in which a fiber end protrudes and loop-shaped fibers raised.

<9> The composite sheet according to any one of <1> to <8> above, wherein a ratio (h_3/h_2) of a height (h_3) of the constituent fibers raised in the recesses to a height (h_2) of the constituent fibers raised in the protrusions is 1 or more, 3 or less, 2 or less, from 1 to 3, or from 1 to 2.

<10> The composite sheet according to any one of <1> to <9> above, wherein the height (h_2) of the constituent fibers raised on the protrusions is 0.5 mm or more, 1 mm or more, 30 mm or less, 20 mm or less, from 0.5 to 30 mm, or from 1 to 20 mm.

<11> The composite sheet according to any one of <1> to <10> above, wherein the number of the constituent fibers raised on the protrusion is 5 or more fibers/10 mm width, 10 or more fibers/10 mm width, 80 or less fibers/10 mm width, 50 or less fibers/10 mm width, from 5 to 80 fibers/10 mm width, or from 10 to 50 fibers/10 mm width.

[0125]

<12> The composite sheet according to any one of <3> to <11> above, wherein the height (h_3) of the constituent fibers raised in the recesses is 0.5 mm or more, 1 mm or more, 30 mm or less, 20 mm or less, from 0.5 to 30 mm, or from 1 to 20 mm.

<13> The composite sheet according to any one of <3> to <12> above, wherein the number of the constituent fibers raised in the recesses is 5 or more fibers/10 mm width, 10 or more fibers/10 mm width, 80 or less fibers/10 mm width, 50 or less fibers/10 mm width, from 5 to 80 fibers/10 mm width, or from 10 to 50 fibers/10 mm width.

<14> The composite sheet according to any one of <1> to <13> above, wherein a ratio of the constituent fibers raised in the recesses and having a raising height of 1 mm or more to the constituent fibers raised in the recesses is 30% or more, 40% or more, 95% or less, from 30 to 95%, or from 40 to 95%.

<15> The composite sheet according to any one of <1> to <14> above, wherein a ratio of the constituent fibers raised in the protrusions and having a raising height of 1 mm or more to the constituent fibers raised in the protrusions is 20% or more, 40% or more, 90% or less, preferably from 80% or less, from 20 to 90%, or from 40 to 80%.

<16> The composite sheet according to any one of <8> to <15> above, wherein a ratio of the loop-shaped fibers raised to the constituent fiber raised is 2% or more, 5% or more, 70% or less, 50% or less, from 2 to 70%, or from 5 to 50%.

<17> The composite sheet according to any one of <1> to <16> above, wherein a thickness of the composite sheet is from 0.5 to 7.0 mm under a load of 0.3 kPa, or from 1.0 to 4.0 mm under a load of 0.3 kPa.

<18> The composite sheet according to any one of <1> to <17> above, wherein the framework material is a mesh sheet, and the mesh sheet is a resin net formed in a latticed shape as a whole.

<19> The composite sheet according to any one of <1> to <17> above, wherein the framework material is a thermally bonded non-woven fabric, and the thermally bonded non-woven fabric is an air-through non-woven fabric, a spunbond non-woven fabric, or a pointbond non-woven fabric.

<20> The composite sheet according to any one of <1> to <19> above, wherein in the fiber aggregation, a ratio of the constituent fiber having a fiber diameter of 20 to 60 μm to the all constituent fibers is from 10 to 90% by mass, or from 30 to 70% by mass.

[0126]

<21> A method for manufacturing the composite sheet according to claim 1, comprising:

performing a fiber-raising processing in which the constituent fibers of the composite sheet are raised; and then

subjecting a plurality of parts of the composite sheet which has been subjected to the fiber-raising processing to an uneven shape-providing processing so that a plurality of protrusions and recesses are formed on the composite sheet.

[0127]

<22> The method for manufacturing the composite sheet according to <21> above, wherein

the fiber-raising processing is performed using a protrusion roll having a plurality of protrusions on its peripheral surface, and

the composite sheet is supplied to the protrusion roll and the fibers forming the fiber aggregation which forms the composite sheet are raised.

<23> The method for manufacturing the composite sheet according to <21> or <22> above, wherein

the uneven shape-providing processing is performed using a pair of uneven rolls,

one roll of the uneven rolls has a plurality of protrusions on its peripheral surface, and the other roll of the uneven rolls has a plurality of recesses, into which the protrusions of the former roll are inserted, at locations corresponding to the protrusions of the former roll on its peripheral surface, and

the composite sheet which has been subjected to the fiber-raising processing is supplied to between a pair of the uneven rolls, and uneven shapes are provided to a plurality of parts of the composite sheet which has been subjected to the fiber-raising processing.

<24> The method for manufacturing the composite sheet according to <22> or <23> above, wherein

a fiber web is overlaid on at least one surface of the framework material,

the overlaid product is subjected to entangling in stream of water, whereby the fibers forming the overlaid product are entangled with each other to form the fiber aggregation and, at the same time, the constituent fibers are entangled with the framework material to integrate the three components.

<25> The method for manufacturing the composite sheet according to any one of <22> to <24> above, wherein

a first protrusion roll and a second protrusion roll are used as the protrusion roll,

the first protrusion roll is disposed on the upstream side of the second protrusion roll,

the first protrusion roll is rotated in a direction opposite to a carrying direction of the fiber aggregation, and

a ratio $V3/V2$ of a peripheral velocity $V3$ of the first protrusion roll to a peripheral velocity $V4$ of the second protrusion roll is adjusted to a value of 0.3 to 20, $V3 > V2$, a value of 1.1 to 15, or a value of 1.5 to 12.

<26> The method for manufacturing the composite sheet according to any one of <22> to <24> above, wherein

a first protrusion roll and a second protrusion roll are provided as the protrusion roll,

the first protrusion roll is disposed on the upstream side of the second protrusion roll,

the first protrusion roll is rotated in a direction forward to a carrying direction of the fiber aggregation, and

a ratio $V3/V2$ of a peripheral velocity $V3$ of the first protrusion roll to a peripheral velocity $V4$ of the second protrusion roll is adjusted to a value of 1.1 to 20, 1.5 to 10, or 2 to 8.

<27> The method for manufacturing the composite sheet according to any one of <21> to <26> above, wherein

the shape-providing processing is performed at a temperature equal to or higher than a softening point of a thermoplastic resin forming the framework material, or a temperature equal to or higher than a melting point of the thermoplastic resin.

[0128]

<28> A cleaning sheet comprising a fiber aggregation and a support supporting the fiber aggregation, constituent fibers of the fiber aggregation being entangled with each other and with the support, thereby forming a state in which the fiber aggregation is integrally entangled with the support, wherein

there are fiber ends of the constituent fibers having a length of 10 mm or longer, which formed by a fiber-raising treatment, more outward than a straight line joining contours of one surface of the cleaning sheet in a side view of the cleaning sheet.

[0129]

<29> The cleaning sheet according to <28> above, wherein there are 10 or more fiber ends per 10 cm² surface of the cleaning sheet.

<30> The cleaning sheet according to <28> or <29> above, wherein the fiber aggregation is formed by hydroentanglement process.

<31> The cleaning sheet according to any one of <28> to <30> above, wherein one surface of the cleaning sheet has unevenness having protrusions and recesses.

<32> The cleaning sheet according to <31> above, wherein the protrusion has more fiber ends than the recess.

<33> The cleaning sheet according to <30> or <31> above, wherein the protrusions and the recesses are formed by hydroentanglement process, which is subjected to the fiber aggregation.

<34> The cleaning sheet according to any one of <28> to <33> above, wherein the fiber ends have a protrusion length of 10 to 30 mm, or 10 to 25 mm.

<35> The cleaning sheet according to any one of <29> to <34> above, wherein there are 10 to 60 fiber ends per 10 cm² surface of the cleaning sheet.

<36> The cleaning sheet according to any one of <31> to <35> above, wherein a protrusion length of the fiber ends in apex parts of the protrusions and in the vicinity thereof (an average value of protrusion lengths of the multiple fiber ends) is longer than a protrusion length of the fiber ends in bottom parts of the recesses and in the vicinity thereof.

<37> The cleaning sheet according to any one of <31> to <36> above, wherein there are relatively more fiber ends in the protrusions than in the recesses.

<38> The cleaning sheet according to any one of <31> to <37> above, wherein an interval between the adjacent protrusions is from 1 to 10 mm, or from 2 to 8 mm in a width direction of the cleaning sheet, and is from 3 to 20 mm or from 4 to 15 mm in a longitudinal direction of the cleaning sheet.

<39> The cleaning sheet according to any one of <31> to <38> above, wherein a relationship between the protrusions on one surface of the cleaning sheet and the recesses on the other surface of the cleaning sheet is an obverse and reverse relationship.

[0130]

<40> The cleaning sheet according to any one of <28> to <39> above, wherein the

cleaning sheet has an apparent thickness of 1 to 5 mm, or 1.3 to 4 mm.

<41> The cleaning sheet according to any one of <28> to <40> above, wherein the support includes a mesh sheet.

<42> The cleaning sheet according to <41> above, wherein the mesh sheet includes a latticed net having many holes, a perforated film having many holes, a loose woven fabric having a comparatively large space between threads, a non-woven fabric or paper having spaces between fibers, or a non-woven fabrics or paper having openings.

<43> The cleaning sheet according to any one of <28> to <42> above, wherein the cleaning sheet has an entangling coefficient of 0.05 to 2 N·m/g or 0.2 to 1.2 N·m/g.

<44> The cleaning sheet according to any one of <28> to <43> above, wherein there are fiber ends of the constituent fibers having a length of 10 mm or more, formed by the fiber-raising treatment, on the other surface located on a side opposite to one surface of the cleaning sheet.

Example

[0131]

The present invention is explained in more detail by means of Examples, but the scope of the present invention is not limited thereto.

[0132]

[Example 1]

A composite sheet was produced in a method shown in FIG. 4. A fiber web having a basis weight of 53 g/m² was obtained using a polyester fiber (1.45 dtex with a fiber length of 38 mm; 100%) as a starting material according to a usual carding method. A polypropylene latticed net (a distance between fibers of 8 mm, and a wire diameter of 300 μm) was used as a mesh sheet, which was a framework. After the fiber web was overlaid on upper and lower sides of the mesh sheet, which was entangled and integrated by jet stream of water jetted from multiple nozzles, and then the resulting product was dried, thereby obtaining a laminate having fiber aggregations. Next, both surfaces of the laminate were subjected to a fiber-raising processing using protrusion rolls 31 and 34. The protrusion rolls 31 and 34 were rotated in a direction opposite to a carrying direction of the laminate, and a jamb angle α was each 130°. Heights of the protrusions 310 and 340 on the protrusion rolls 31 and 34 are about 0.07 mm; a distance (a pitch) between adjacent protrusions in a circumferential direction, and

a distance (a pitch) of adjacent protrusions in a direction of an axis of rotation are each about 0.22 mm; and the number of protrusions per unit area was 2000 protrusions/cm². Next, the laminate was passed through a steel-match embossing roller 43 to perform an uneven shape-providing (deformation) processing. A roll 41 and a roll 42 had a surface temperature of 105°C. Each protrusion 410 on the roll 41 had a height of 2.0 mm, and an engagement depth between each protrusion 410 on the roll 41 and each recess 420 on the roll 42 was 1.6 mm. In addition, a distance (a pitch) between adjacent protrusions 410 in the direction of the axis of rotation was 7 mm, and a distance (a pitch) between adjacent protrusions 410 in the circumferential direction was 7 mm. A composite sheet of Example 1 was manufactured under the conditions described above.

[0133]

[Example 2]

A composite sheet of Example 2 was manufactured in the same manner as in Example 1, except that a polyester fiber (1.45 dtex with a fiber length of 38 mm/9.0 dtex with a fiber length of 38 mm: 70%/30%) was used as the starting material of the fiber web.

[0134]

[Example 3]

A composite sheet of Example 3 was manufactured in the same manner as in Example 1, except that a polyester fiber (1.45 dtex with a fiber length of 38 mm/9.0 dtex with a fiber length of 38 mm: 50%/50%) was used as the starting material of the fiber web.

[0135]

[Example 4]

A composite sheet of Example 4 was manufactured in the same manner as in Example 1, except that a polyester fiber (1.45 dtex with a fiber length of 38 mm/17.0 dtex with a fiber length of 51 mm: 70%/30%) was used as the starting material of the fiber web.

[0136]

[Example 5]

A composite sheet of Example 5 was manufactured in the same manner as in Example 1, except that a polyester fiber (1.45 dtex with a fiber length of 38 mm/17.0 dtex with a fiber length of 51 mm: 50%/50%) was used as the starting material of the fiber web.

[0137]

[Comparative Example 1]

A fiber web having a basis weight of 53 g/m² was obtained in the same manner as in Example 1, using a polyester fiber (1.45 dtex with a fiber length of 38 mm: 100%) as a starting material according to a usual carding method. A polypropylene latticed net (a distance between fibers of 8 mm, a wire diameter of 300 μm) was used as a mesh sheet, which was a framework, as in Example 1. After the fiber web was overlaid on upper and lower sides of the mesh sheet, which was entangled and integrated by jet stream of water jetted from multiple nozzles, and then the resulting product was dried, thereby obtaining a laminate having fiber aggregations, in the same manner as in Example 1. Next, a fiber-raising step was performed under the same conditions as in Example 1 except that the uneven three-dimensional shape-providing (deformation) processing was not performed, thereby producing a composite sheet of Comparative Example 1.

[0138]

[Comparative Example 2]

A fiber web having a basis weight of 53 g/m² was obtained in the same manner as in Example 1, using a polyester fiber (1.45 dtex with a fiber length of 38 mm: 100%) as a starting material according to a usual carding method. A polypropylene latticed net (a distance between fibers of 8 mm, a wire diameter of 300 μm) was used as a mesh sheet, which was a framework, as in Example 1. After the fiber web was overlaid on upper and lower sides of the mesh sheet, which was entangled and integrated by jet stream of water jetted from multiple nozzles, and then the resulting product was dried, thereby obtaining a laminate having fiber aggregations, in the same manner as in Example 1. Next, only an uneven three-dimensional shape-providing (deformation) process was performed under the same conditions as in Example 1 without performing

the fiber-raising step, thereby producing a composite sheet of Comparative Example 2.

[0139]

[Comparative Example 3]

A fiber web having a basis weight of 53 g/m^2 was obtained in the same manner as in Example 1, using a polyester fiber (1.45 dtex with a fiber length of 38 mm: 100%) as a starting material according to a usual carding method. A polypropylene latticed net (a distance between fibers of 8 mm, a wire diameter of $300 \text{ }\mu\text{m}$) was used as a mesh sheet, which was a framework, as in Example 1. After the fiber web was overlaid on upper and lower sides of the mesh sheet, which was entangled and integrated by jet stream of water jetted from multiple nozzles, and then the resulting product was dried, thereby obtaining a laminate having fiber aggregations, in the same manner as in Example 1. In Comparative Example 3, a fiber-raising step and an uneven three-dimensional shape-providing (deformation) processing were performed in an opposite order of the order in Examples 1; i.e., the laminate was subjected to an uneven three-dimensional shape-providing (deformation) processing under the same conditions as in Example 1, and then both surfaces thereof was subjected to a fiber-raising processing with #1200 sandpaper, thereby producing a composite sheet of Comparative Example 3.

[0140]

[Comparative Example 4]

A fiber web having a basis weight of 53 g/m^2 was obtained in the same manner as in Example 1, using a polyester fiber (1.45 dtex with a fiber length of 38 mm: 100%) as a starting material according to a usual carding method. A polypropylene latticed net (a distance between fibers of 8 mm, a wire diameter of $300 \text{ }\mu\text{m}$) was used as a mesh sheet, which was a framework, as in Example 1. After the fiber web was overlaid on upper and lower sides of the mesh sheet, which was entangled and integrated by jet stream of water jetted from multiple nozzles, and then the resulting product was dried, thereby obtaining a laminate having fiber aggregations, in the same manner as in Example 1. The fiber entangling was made weak by reducing a water pressure of the jet stream of water, or the like. The fiber-raising step and the uneven three-dimensional shape-providing (deformation) processing were not performed, thereby producing a composite sheet of Comparative Example 4.

[0141]

[Comparative Example 5]

A fiber web having a basis weight of 53 g/m² was obtained in the same manner as in Example 1, using a polyester fiber (1.45 dtex with a fiber length of 38 mm: 100%) as a starting material according to a usual carding method. A polypropylene latticed net (a distance between fibers of 8 mm, a wire diameter of 300 μm) was used as a mesh sheet, which was a framework, as in Example 1. After the fiber web was overlaid on upper and lower sides of the mesh sheet, which was entangled and integrated by jet stream of water jetted from multiple nozzles, and then the resulting product was dried, thereby obtaining a laminate having fiber aggregations, in the same manner as in Example 1. The fiber entangling by jet stream of water was performed as in Examples. The fiber-raising step and the uneven three-dimensional shape-providing (deformation) processing were not performed as in Comparative Example 4, thereby producing a composite sheet of Comparative Example 5.

[0142]

[Comparative Example 6]

A fiber web having a basis weight of 53 g/m² was obtained in the same manner as in Example 1, using a polyester fiber (1.45 dtex with a fiber length of 38 mm: 100%) as a starting material according to a usual carding method. A polypropylene latticed net (a distance between fibers of 8 mm, a wire diameter of 300 μm) was used as a mesh sheet, which was a framework, as in Example 1. After the fiber web was overlaid on upper and lower sides of the mesh sheet, which was entangled and integrated by jet stream of water jetted from multiple nozzles, and then the resulting product was dried, thereby obtaining a laminate having fiber aggregations, in the same manner as in Example 1. The fiber entangling was made strong by increasing a water pressure of the jet stream of water, or the like. As in Example 4, the fiber-raising step and the uneven three-dimensional shape-providing (deformation) processing were not performed, thereby producing a composite sheet of Comparative Example 6.

[0143]

[Evaluation of Property]

A thickness under a load of 40 Pa, 0.3 kPa and 0.7 kPa and a basis weight were obtained for each composite sheet in Examples 1 to 5 and Comparative Examples 1 to 6,

and the results are shown in Table 1.

The catching property was measured as described below, when each composite sheet from Examples 1 to 5 and Comparative Examples 1 to 6 was used as a cleaning sheet.

[0144]

[Hair-Catching Property]

<Hair-Catching Property on Dry Floor>

Each composite sheet of Examples 1 to 5 and Comparative Examples 1 to 6 was attached to Quikkle Wiper [manufactured by Kao Corporation]. Ten strands of hair having a length of about 10 cm were scattered on a 30 cm × 90 cm wooden floor (NEW Woody Super Z manufactured by Matsushita Electric Corporation), on which a head part to which the composite sheet was attached was put, and back-and-forth cleaning was performed once at a certain stroke (90 cm). After that, electricity was removed from the composite sheet catching the strands of hair by using a static eliminator SJ-R036 (manufactured by KEYENCE Corporation) and the head part was shaken 10 times, and then the number of the strands of hair caught on the composite sheet was measured. This operation was performed three times repeatedly, and how many strands of hair were caught in 30 strands of hair was measured. The number of the strands of hair caught was divided by 30, which was multiplied by 100, and the obtained value was defined as a hair-catching ratio (%).

A catching ratio of strands of hair having a length of about 20 cm was calculated in the same manner as above.

[0145]

[Hair-Catching Property]

<Hair-Catching Property on Wet Floor>

Each composite sheet of Examples 1 to 5 and Comparative Examples 1 to 6 was attached to Quikkle Wiper [manufactured by Kao Corporation]. To a 30 cm × 90 cm wooden floor (NEW Woody Super Z manufactured by Matsushita Electric Corporation) was added dropwise 0.3 cc ion-exchanged water, and the water was spread to range of a wiper head size (about 10 cm × 25 cm), on which ten strands of hair having a length of about 10 cm were scattered, and the strands of hair were adapted to the ion-exchanged water by a finger. A head part to which the composite sheet was

attached was put thereon, and back-and-forth cleaning was performed 5 times at a certain stroke (90 cm). After that, electricity was removed from the composite sheet catching the strands of hair by using a static eliminator SJ-R036 (manufactured by KEYENCE Corporation) and the head part was shaken 10 times, and then the number of the strands of hair caught on the composite sheet was measured. This operation was performed three times repeatedly, and how many strands of hair were caught in 30 strands of hair was measured. The number of the strands of hair caught was divided by 30, which was multiplied by 100, and the obtained value was defined as a hair-catching ratio (%).

The hair-catching property of the sheet on the dry floor or the wet floor was evaluated based on the following criteria:

A: A catching ratio of 80% or more, and a good hair-catching property.

B: A catching ratio of 60% or more and less than 80%, and a hair-catching property sufficient for practical use.

C: A catching ratio of 40% or more and less than 60%, and a poor hair-catching property.

D: A catching ratio of less than 40%, and a hair-catching property impossible for practical use.

[0146]

[Particulate Garbage-Catching Property]

Each composite sheet of Examples 1 to 5 and Comparative Examples 1 to 3 was attached to Quickle Wiper [manufactured by Kao Corporation]. Ten seeds of sesame, which was particulate garbage, were scattered on a 30 cm × 90 cm wooden floor (NEW Woody Super Z manufactured by Matsushita Electric Corporation), on which a head part to which the composite sheet was attached was put, and back-and-forth cleaning was performed once at a certain stroke (90 cm). After that, the head part to which the composite sheet catching the seeds of sesame was shaken 10 times, and the number of the seeds of sesame caught on the composite sheet was measured. This operation was performed three times repeatedly, and how many seeds of sesame were caught in 30 seeds of sesame was measured. The number of the seeds of sesame was divided by 30, which was multiplied by 100, and the obtained value was defined as a particulate garbage-catching ratio (%).

[0147]

[Table 1]

	Unit	Example 1	Example 2	Example 3	Example 4	Example 5	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6
Forming step		Fiber-raising→SM (Steel-match embossing)					Only fiber-raising	Only SM	SM→Sandpaper	Only entangling (weak entangling)	Only entangling (same level as in Examples)	Only entangling (strong entangling)
Fiber composition	Ratio	1.45d	1.45d/9d		1.45d/17d		1.45d					
		100%	70%/30%	50%/50%	70%/30%	50%/50%	100%					
Basis weight	g/m ²	55.4	49.4	52.9	55.5	63.2	53.6	55.4	55.5	54.2	51.3	53.6
Thickness under a load of 40 Pa	mm	2.20	2.13	2.24	2.20	2.53	1.39	2.12	2.41	1.01	1.09	1.28
Thickness under a load of 300 Pa	mm	1.47	1.37	1.42	1.46	1.63	0.81	1.41	1.56	0.76	0.69	0.86
Thickness under a load of 700 Pa	mm	1.19	1.13	1.16	1.26	1.35	0.81	1.00	1.12	0.66	0.64	0.82
Dry floor, hair-catching ratio 10 cm		A	A	A	A	A	A	C	A	C	D	D
Dry floor, hair-catching ratio 20 cm		B	B	B	A	A	B	D	C	D	D	D
Wet floor, hair-catching ratio		B	A	A	A	A	A	C	C	C	D	D
Dry floor, particulate garbage-catching ratio		B	B	A	B	A	C	C	B	D	D	D

[0148]

In addition, a height (h2) of the constituent fiber raised on the apex part of the protrusion, a height (h3) of the constituent fiber raised in the bottom part of the recess, and a ratio (h3/h2) of each composite sheet from Examples 1 to 5 and Comparative Examples 1 to 6 were obtained based on "Method of Measuring Height of Constituent fibers Raised," and the results are shown in Table 2. The composite sheets from Comparative Examples 1 and 4 to 6 were not subjected to the uneven three-dimensional shape-providing (deformation) processing, and thus a height of the constituent fibers raised on the surface of the composite sheet was similarly measured.

As for each composite sheet from Examples 1 to 5 and Comparative Examples 1 to 6, a ratio (%) of constituent fibers raised 0.1 mm or more and less than 1 mm, 1 mm or more and less than 3 mm, 3 mm or more and less than 10 mm, or 10 mm or more on the protrusions were obtained based on the method described above. In addition, a ratio (%) of the constituent fiber in the recesses was obtained in the same manner as in the ratio about the protrusions, and the results are shown in Table 2. Each composite sheet from Comparative Examples 1 and 4 to 6 was not subjected to the uneven three-dimensional shape-providing (deformation) processing, and thus a ratio of the constituent fibers raised on the surface of the composite sheet was similarly measured.

In addition, a ratio of loop-shaped fibers in the protrusions or recesses of each composite sheet from Examples 1 to 5 and Comparative Examples 1 to 6 were measured based on "Method of Measuring Ratio of Loop-Shaped Fibers," and the results are shown in Table 2. Each composite sheet from Comparative Examples 1 and 4 to 6 was not subjected to the uneven three-dimensional shape-providing (deformation) processing, and thus a ratio of the loop-shaped constituent fibers raised on the surface of the composite sheet was similarly measured.

0.1 mm or more and less than 1.0 mm	28.2%	26.2%	20.5%	22.0%	21.7%	20.0%	17.0%		
1.0 mm or more and less than 3.0 mm	48.2%	42.2%	47.1%	42.5%	40.7%	9.2%	19.5%		
3.0 mm or more and less than 10.0 mm	36.5%	19.3%	24.0%	20.9%	23.9%	0.0%	1.5%		
10.0 mm or more	4.4%	2.2%	1.9%	4.6%	3.5%	0.0%	0.0%		
ave(h3)	3.73	2.23	2.65	2.79	2.75	0.51	0.71		
max	14.50	13.00	17.00	17.00	17.00	2.32	3.11		
min	0.27	0.18	0.33	0.11	0.41	0.10	0.13		
	1.3	1.1	1.1	1.2	1.0	0.7	0.5		
	27	26	25	28	28	16	27		
	37	35	27	31	30	19	17		
	33	11	23	19	11	61	9		
	29	13	33	19	10	75	31		
0.1 mm or more and less than 1.0 mm					33.8%		65.0%	93.6%	94.9%
1.0 mm or more and less than 3.0 mm					37.2%		29.1%	6.4%	5.1%
3.0 mm or more and less than 10.0 mm					23.0%		5.1%	0.0%	0.0%
10.0 mm or more					6.0%		0.9%	0.0%	0.0%
ave					2.84		1.22	0.53	0.50
max					22.00		11.50	2.40	2.22
min					0.15		0.12	0.10	0.15
					18		12	11	12
					20		23.9	55.2	81.2

[0150]

As apparent from the results in shown Table 1, the hair-catching property and the particulate garbage-catching property of the composite sheets of Examples 1 to 5 were higher than those of the composite sheets of Comparative Examples 1 to 6.

As apparent from the results shown in Table 2, the height and the number of the constituent fibers raised in the bottom parts of the recesses of the composite sheets of Examples 1 to 5 were, respectively, higher and more than those of the composite sheets of Comparative Examples 2 and 3.

As apparent from the results shown in Table 2, the composite sheets of Examples 1 to 5 had a tendency in which the larger the diameter of the constituent fiber, the smaller the number of the fibers raised, but it can be assumed that because the fibers having a large fiber diameter had a high rigidity, an effect in which things such as hair and seeds of sesame caught were strongly caught without dropping them off due to the fiber rigidity when the things were caught, could be exerted.

[0151]

[Example 6]

Next, a cleaning sheet having the same structure as the cleaning sheet 1B shown in FIG. 12 and FIG. 13 was produced using a manufacturing apparatus as shown in FIG. 18 and FIG. 19, which were used as a sample in Example 6. Specifically, first, a fiber web having a basis weight of 24 g/m^2 was obtained using a PET fiber (fiber size of $11 \text{ }\mu\text{m}$, a fiber length of 38 mm) as a starting material according to a usual carding method. Then, using a polypropylene latticed net (a wire diameter of $300 \text{ }\mu\text{m}$, a distance between wires of 8 mm , and a basis weight of 5 g/m^2) as a support (a mesh sheet), the obtained fiber web was overlaid on upper and lower surfaces of the support to obtain a overlaid product (an overlaying step); the overlaid product was subjected to an entangling treatment using jet stream of water (a water pressure of 1 to MPa) jetted from multiple nozzles to entangle and integrate them, thereby obtaining a composite having fiber aggregations with an entangling coefficient of $0.5 \text{ N}\cdot\text{m/g}$ (a spun lace non-woven fabric) (an entangling step); an uneven shape was provided to the composite by applying jet stream of water jetted from multiple nozzles thereto on patterning member a under a condition of a water pressure of 1 to 5 MPa, to obtain an uneven composite(an unevenness-providing step); and the resulting uneven composite was hot-air dried (a drying step). Then, only one surface of the obtained uneven composite

was subjected to a fiber-raising treatment by using a fiber-raising processing roll (a fiber-raising step), whereby a cleaning sheet having desired protrusions and recesses was obtained. Using a sandblasting roll as the fiber-raising processing roll, a carrying speed V1b (see FIG. 19) of the uneven composite was set at 20 m/min, a peripheral velocity V2b (see FIG. 19) of the sandblasting roll was set at 200 m/min, and the sandblasting roll was rotated in a direction opposite to the carrying direction of the uneven composite. A height of protrusions on a peripheral surface of the sandblasting roll was about 0.07 mm, a distance (a pitch) of adjacent protrusions in the circumferential direction and a distance (a pitch) of adjacent protrusions in the axis of rotation direction were about 0.22 mm, an area of a tip of an apex part of the protrusion was about 0.008 mm^2 , and the number of protrusions per unit area was about 2000 protrusions/cm².

[0152]

[Example 7]

A cleaning sheet having protrusions and recesses was produced in the same manner as in Example 6 except that the peripheral velocity V2b of the sandblasting roll was set at 20 m/min, which was defined as Example 7.

[0153]

[Example 8]

A cleaning sheet having protrusions and recesses was produced in the same manner as in Example 6 except that the peripheral velocity V2b of the sandblasting roll was set at 10 m/min, which was defined as Example 8.

[0154]

[Example 9]

A cleaning sheet was produced in the same manner as in Example 6 except that a PET fiber (a fiber size of 11 μm and a fiber length of 38 mm) and a core sheath conjugated fiber (a core part of PP and a sheath part of PE, a fiber size of 48 μm , and a fiber length of 51 mm) were used as the starting material for the fiber web; a mixing mass ratio of the two fibers was set at the PET fiber : the core sheath conjugated fiber = 45:55; and the unevenness-providing step was omitted, which was defined as Example

9. The omission of the unevenness-providing step made the obtained cleaning sheet flat with substantially no protrusions or recesses.

[0155]

[Example 10]

A cleaning sheet having protrusions and recesses was produced in the same manner as in Example 6 except that a PET fiber (a fiber size of 11 μm , and a fiber length of 38 mm) and a core sheath conjugated fiber (a core part of PP, a sheath part of PE, a fiber size of 40 μm , and a fiber length of 51 mm) were used as the starting material of the fiber web, and a mixing mass ratio of the two fibers was set at the PET fiber : the core sheath conjugated fiber = 45:55, which was defined as Example 10.

[0156]

[Example 11]

A cleaning sheet having protrusions and recesses was produced in the same manner as in Example 6 except that two kinds of PET fibers whose fiber size and fiber length were different from each other [a first PET fiber (a fiber size of 11 μm , and a fiber length of 38 mm) and a second PET fiber (a fiber size of 32 μm and a fiber length of 51 mm)] was used as the starting material of the fiber web, and the mixing mass ratio of the two fibers was set at the first PET fiber : the second PET fiber = 45:55, which was defined as Example 11.

[0157]

[Example 12]

A cleaning sheet having substantially no protrusions or recesses was produced in the same manner as in Example 6 except that a PET/nylon dividable fiber (a fiber size of about 7 μm after the division, and a fiber length of 51 mm) was used as the starting materials of the fiber web, and the unevenness-providing step was omitted, which was defined as Example 12.

[0158]

[Example 13]

A cleaning sheet having protrusions and recesses was produced in the same

manner as in Example 6 except that a perforated spun lace non-woven fabric of rayon fiber [a rayon fineness of 2.2 dtex, a basis weight of 40 g/m², an opening size (1.5 mm in MD and 0.5 mm in CD), and a rate of hole area of 30%] was used as the support (the mesh sheet), which was defined as Example 13.

[0159]

[Example 14]

A cleaning sheet having substantially no protrusions or recesses was produced in the same manner as in Example 6 except that the unevenness-providing step was omitted, which was defined as Example 14.

[0160]

[Comparative Example 7]

A cleaning sheet having protrusions and recesses was produced in the same manner as in Example 6 except that the fiber-raising step was omitted, which was defined as Comparative Example 7.

[0161]

[Comparative Example 8]

First, a fiber web having a basis weight of 30 g/m² was obtained using a core sheath conjugated fiber (a core part of PP, a sheath part of PE, a fiber size of 17 μ m, and a fiber length of 51 mm) according to a usual carding method. Next, the fiber web was subjected to a heat-treatment at 135°C to melt the fibers to each other, thereby obtaining an air-through non-woven fabric. The thus obtained air-through non-woven fabric was subjected to a fiber-raising treatment in the same manner as in the fiber-raising step of Example 6, thereby producing a cleaning sheet having substantially no protrusions or recesses, which was defined as Comparative Example 8.

[0162]

[Comparative Example 9]

A spunbond non-woven fabric having a basis weight of 30 g/m² of a PET fiber (a continuous fiber with a fiber size of 25 μ m) was subjected to a fiber-raising treatment

in the same manner as in the fiber-raising step of Example 6, thereby obtaining a cleaning sheet having substantially no protrusions or recesses, which was defined as Comparative Example 9.

[0163]

[Comparative Example 10]

A cleaning sheet having substantially no protrusions or recesses was produced in the same manner as in Example 6, except that only fiber web was formed into a sheet using no support (mesh sheet), and the protrusion-providing step was omitted, which was defined as Comparative Example 10.

[0164]

[Comparative Example 11]

A cleaning sheet having substantially no protrusions or recesses was produced in the same manner as in Example 6, except that the unevenness-providing step and the fiber-raising step were omitted, which was defined as Comparative Example 11.

[0165]

[Evaluation]

A protrusion length of the fiber end from the fiber aggregation and the number of long fiber ends of each sample (a cleaning sheet) of Examples and Comparative Examples were evaluated according to the methods described above. In addition, a hair-catching property on each of a dry surface to be cleaned and a wet surface to be cleaned, a fine dust-catching property, a larger particulate garbage-catching property, a sheet elongation, a degree of dropping-off of fibers, and a wiping resistance were evaluated according to the following methods. The evaluations were performed in an environment of room temperature of 20°C and a humidity of 60% RH. The results are shown in Table 3 described below.

[0166]

Separately, the fiber ends protruding from the fiber aggregation [including fiber ends of the constituent fibers with a length of 10 mm or longer (the long fiber ends)] of each sample (the cleaning sheet) in Examples and Comparative Examples were visually

observed. As a result, in the cleaning sheets having protrusions and recesses (the samples of Examples 6 to 8, 10, 11 and 13, and Comparative Example 7), there are relatively more fiber ends on the protrusions forming the unevenness (an apex part of the protrusion and in the vicinity thereof), and there are relatively a fewer fiber ends in the recesses forming the unevenness (a bottom part of the recess and in the vicinity thereof). On the other hand, in the cleaning sheet having substantially no protrusions and recesses (the samples of Examples 9, 12 and 14, and Comparative Examples 8 to 11), the fiber ends existed almost uniformly over the whole surface of one surface (the fiber-raising treatment surface) of the cleaning sheet.

[0167]

<Evaluation Method of Hair-Catching Property on Dry Surface to be Cleaned>

The cleaning sheet was attached to a head part of Quickle Wiper (a registered trademark), which was a cleaning tool manufactured by Kao Corporation. In the evaluation, a surface to which the fiber-raising treatment was subjected (the fiber-raising treatment surface) during the production process of the cleaning sheet was used as a cleaning surface. When there was no fiber-raising treatment surface, an arbitral one surface of the cleaning sheet was used as the cleaning surface. Using a dry wooden floor surface (size of 30 cm × 60 cm, Woody F manufactured by Matsushita Electric Corporation) as the surface to be cleaned, ten strands of hair having a length of about 10 cm were scattered thereon, and then the cleaning sheet attached to the head part was put on the floor, and the whole area of the wooden floor was wiped once at a certain stroke (60 cm), whereby the cleaning sheet caught the strands of hair. After that, the head part of the Quickle Wiper was shaken 10 times at an up and down stroke of 10 cm, whereby the strands of hair, which were not held by the cleaning sheet, were dropped off, and then the number of the strands of hair held on the cleaning sheet was counted. Five sheets of one kind of the cleaning sheet were continuously subjected to this operation, and the total number of the strands of hair caught on the five cleaning sheets (the total number of the strands of hair caught) was recorded. The number of the strands of hair caught was divided by 50 (the total number of the strands of hair scattered), which was multiplied by 100, and the obtained value was defined as a retention (%) of the hair caught. The retention was evaluated based on the following criteria as the hair-catching property on the dry surface to be cleaned.

A: A retention of 80% or more, and a good hair-catching property on the dry surface to be cleaned.

B: A retention of 60% or more and less than 80%, and a hair-catching property on the dry surface to be cleaned sufficient for practical use.

C: A retention of 40% or more and less than 60%, and a hair-catching property on the surface to be cleaned hair-catching property slightly poor but possible for practical use.

D: A retention of less than 40%, a hair-catching property on the dry surface to be cleaned impossible for practical use.

[0168]

<Evaluation Method of Hair-Catching Property on Wet Surface to be Cleaned>

In <Evaluation Method of Hair-Catching Property on Dry Surface to be Cleaned> described above, after ten strands of hair were scattered on the surface to be cleaned, 1 ml of ion-exchanged water was spread thereon, and the strands of hair were adapted to the ion-exchanged water. After that, a retention (%) of the hair caught was obtained in the same manner as above, and the retention was evaluated based on the following criteria described below as the hair-catching property on the wet surface to be cleaned.

A: A retention of 80% or more, and a good hair-catching property on the dry surface to be cleaned.

B: A retention of 60% or more and less than 80%, and a hair-catching property on the dry surface to be cleaned sufficient for practical use.

C: A retention of 40% or more and less than 60%, and a hair-catching property on the surface to be cleaned hair-catching property slightly poor but possible for practical use.

D: A retention of less than 40%, a hair-catching property on the dry surface to be cleaned impossible for practical use.

[0169]

<Evaluation Method of Fine Dust-Catching Property>

The cleaning sheet was attached to a head part of Quickle Wiper (a registered trademark), which was a cleaning tool manufactured by Kao Corporation. For the

evaluation of the dust-catching property, fine dust was used. In the evaluation, a surface to which the fiber-raising treatment was subjected (the fiber-raising treatment surface) during the production process of the cleaning sheet was used as a cleaning surface. When there was no fiber-raising treatment surface, an arbitral one surface of the cleaning sheet was used as the cleaning surface. After 0.2 g (the total weight of the 7 kinds of powders was 0.2 g) of 7 kinds of Test Dust powders (manufactured by the Association of Powder Process Industry and Engineering, Japan, "7 kinds of Test Powders 1 prescribed in "Test Powder and Test Particles" in "JIS Z 8901" were scattered on almost the whole surface of a dry wooden floor surface (size of 90 cm × 90 cm, Woody F manufactured by Matsushita Electric Corporation) as the surface to be cleaned, the whole area of the wooden floor was wiped twice at a certain stroke (60 cm) with the cleaning sheet attached to the head part, and a mass of the dust attached to the cleaning sheet was measured. The mass of the dust attached to the cleaning sheet was measured by subtracting a mass of the cleaning sheet before wiping, which had been previously measured, from a total mass of the cleaning sheet after wiping. Five sheets of one kind of the cleaning sheet were continuously subjected to this operation, and the total mass of the dust caught on the five cleaning sheets (the total mass of the dust caught) was recorded. The total mass of the dust caught was divided by 1.0 (the total mass of the dust scattered), which was multiplied by 100, and the obtained value was defined as a fine dust-catching ratio (%), and the catching ratio was evaluated based on the following criteria as the dust-catching property.

- A: A catching ratio of 70% or more, and a good fine dust-catching property.
- B: A catching ratio of 50% or more and less than 70%, and a fine dust-catching property sufficient for practical use.
- C: A catching ratio of 40% or more and less than 50%, a fine dust-catching property slightly poor but possible for practical use.
- D: A catching ratio of less than 40%, and a fine dust-catching property impossible for practical use.

[0170]

<Evaluation Method of Larger Particulate Garbage-Catching Property>

The cleaning sheet was attached to a head part of Quickle Wiper (a registered trademark), which was a cleaning tool manufactured by Kao Corporation. In the

evaluation, a surface to which the fiber-raising treatment was subjected (the fiber-raising treatment surface) during the production process of the cleaning sheet was used as a cleaning surface. When there was no fiber-raising treatment surface, an arbitral one surface of the cleaning sheet was used as the cleaning surface. Using a dry wooden floor surface (size of 30 cm × 60 cm, Woody F manufactured by Matsushita Electric Corporation) as the surface to be cleaned, 0.5 g of bread crumbs having a particle size of about 1.0 to 1.4 mm as the larger particulate garbage were scattered on the wooden floor, and then the cleaning sheet attached to the head part was put on the floor. The whole area of the wooden floor was wiped once at a certain stroke (60 cm), whereby the cleaning sheet caught the bread crumbs, and a mass of the bread crumbs caught was measured. The mass of the bread crumbs attached to the cleaning sheet was measured by subtracting a mass of the cleaning sheet before wiping, which had been previously measured, from a total mass of the cleaning sheet after wiping. Five sheets of one kind of the cleaning sheet were continuously subjected to this operation, and the total mass of the bread crumbs caught on the five cleaning sheets (the total mass of the crumbs caught) was recorded. The total mass of the crumbs caught was divided by 2.5 (the total mass of the bread crumbs scattered), which was multiplied by 100, and the obtained value was defined as a larger particulate garbage catching ratio (%), and the catching ratio was evaluated based on the following criteria as the larger particulate garbage-catching property.

- A: A catching ratio of 50% or more, and a good larger particulate garbage-catching property.
- B: A catching ratio of 30% or more and less than 50%, a larger particulate garbage-catching property sufficient for practical use.
- C: A catching ratio of 15% or more and less than 30%, and a larger particulate garbage-catching property slightly poor, but possible for practical use.
- D: A catching ratio of less than 15%, and a larger particulate garbage-catching property impossible for practical use.

[0171]

<Evaluation of Sheet Elongation>

A cleaning sheet to be cut was cut into a rectangular shape having a size of 100 mm in CD and 30 mm in MD, a direction orthogonal to the CD, and the cut rectangular

shape was used as a measurement sample. The measurement sample was attached to chucks of a tensile tester so that the tensile direction is the CD. A distance between the chucks was set at 50 mm. The measurement sample was stretched at 300 mm/min. Using a length of the measurement sample at elongation under a load of 5N, a sheet elongation in CD under a load of 5 N/25 mm was obtained by the following formula, and evaluation was performed based on the following criteria.

$$\text{Sheet elongation (\%)} = [(a \text{ length at elongation} - 50)/50] \times 100$$

A: A sheet elongation of less than 10%, the cleaning sheet was not entirely stretched at the wiping on the surface to be cleaned or at the attachment thereof to the cleaning tool, and it was easy to use.

B: A sheet elongation of 10% or more and less than 20%, the cleaning sheet was hardly stretched at the wiping on the surface to be cleaned or at the attachment thereof to the cleaning tool, and it had no problem for practical use.

C: A sheet elongation of 20% or more and less than 40%, the cleaning sheet was sometimes stretched at the wiping on the surface to be cleaned or at the attachment thereof to the cleaning tool, and it had a slightly poor usability but could be practically used.

D: A sheet elongation of 40% or more, the cleaning sheet was stretched at the wiping on the surface to be cleaned or at the attachment thereof to the cleaning tool, and it was not suited for use.

[0172]

<Evaluation Method of Degree of Dropping-Off of Fibers>

The cleaning sheet was attached to a head part of Quickle Wiper (a registered trademark), which was a cleaning tool manufactured by Kao Corporation. In the evaluation, a surface to which the fiber-raising treatment was subjected (the fiber-raising treatment surface) during the production process of the cleaning sheet was used as a cleaning surface. When there was no fiber-raising treatment surface, an arbitral one surface of the cleaning sheet was used as the cleaning surface. Using the cleaning sheet attached to the head part, back-and-forth cleaning was performed five times over the whole area of one mat of a tatami mat, which was the surface to be

cleaned. After that, whether or not the constituent fibers of the cleaning sheet remained on the tatami mat was visibly observed, and it was evaluated based on the following criteria as the degree of dropping-off of the fibers.

B: The number of the constituent fibers remaining on the tatami mat was less than 10, the low degree of dropping-off of the fibers was low, and the evaluation was high.

C: The number of the constituent fibers remaining on the tatami mat was 10 or more, the degree of dropping-off of the fibers was slightly high, but it could be practically used.

D: The cleaning sheet was broken by the cleaning, and it could not be practically used.

[0173]

<Evaluation of Wiping Resistance>

Five circles having a diameter of 25 mm were cut from the cleaning sheet as a sample. A coefficient of static friction μ of the fiber-raising treatment surface (when the sample had no fiber-raising treatment, an arbitrary surface of the cleaning sheet) of each sample was measured using HEIDON Tribogear Muse TYPE: 94i, manufactured by Shinto Scientific Co., Ltd. An average value of coefficients of static friction μ of the 5 samples was evaluated based on the following criteria as the wiping resistance.

B: An average value of less than 0.40 μ , a low wiping resistance, and a good feel of wiping.

C: An average value of 0.40 μ or more and less than 0.60 μ , a high wiping resistance, a slightly poor feel of wiping, but it could be practically used.

D: An average value of 0.60 μ or more, a very high wiping resistance, a poor feel of wiping, and it could not be practically used.

	300	300	300	300	300	300	12	300	300	-	-	-	300
	5	5	5	5	5	5	40	5	5	-	-	-	5
	Presence	Presence	Absence	Presence	Presence	Absence	Presence	Absence	Presence	Absence	Absence	Absence	Absence
	Presence	Presence	Presence	Presence	Presence	Presence	Presence	Presence	Absence	Presence	Presence	Presence	Absence
	20	10	200	200	200	200	200	200	-	200	200	200	-
	17	17	21	20	20	11	21	15	7	11	25	18	7
	11	8	44	27	25	2	48	31	0	8	21	31	0
	A	B	A	A	A	A	A	B	C	D	D	B	C
	B	C	A	A	A	A	A	B	D	D	D	B	D
	A	A	C	B	B	A	A	A	A	B	B	A	B
	B	B	A	A	A	A	A	B	C	C	D	B	C
	A	A	A	A	A	A	B	A	A	C	A	D	A
	B	B	C	B	B	B	B	B	B	B	B	B	B
	B	B	B	B	B	C	B	B	B	B	B	B	B

[0175]

As apparent from the results shown in Table 3, in the cleaning sheets of Examples 6 to 14, any fiber aggregation has sites formed by entangling the constituent fibers, the fiber aggregations and the support are formed into an integrally entangled state. In addition, in the cleaning sheets of Examples 6 to 14, the length of the fiber ends protruding from the fiber aggregation is 10 mm or more, and there are the fiber ends of the constituent fibers having a length of 10 mm or more (the long fiber ends) more outward the straight line BLb (see FIG. 14) joining the contours of one surface of the cleaning sheet (fiber-raising treatment surface of the cleaning surface) in a side view of the cleaning sheet. It can be seen accordingly that the cleaning sheets of Examples 6 to 14 have excellent cleaning performance (the hair-catching property on the dry surface to be cleaned), and other cleaning performances (the hair-catching property on the wet surface to be cleaned, the fine dust-catching property, and the larger particulate garbage-catching property) thereof are more improved compared to Comparative Example 7 in which the fiber-raising treatment is not performed. Further, it can be seen that Examples 6 to 14 are cleaning sheets having the low sheet elongation and thus are suitable for cleaning. In addition, from the comparison of Example 13 to other Examples, it can be seen that even if the rayon perforated spun lace non-woven fabric is used as the support, the cleaning sheet has the low sheet elongation and thus has the preferable structure as the cleaning sheet. On the contrary, in Comparative Examples 7 and 11, mainly, the fiber-raising treatment is not performed, and there are no long fiber ends on the cleaning surface, and thus the results of the poor cleaning performances are obtained. In Comparative Examples 8 and 9, though there are the long fiber ends on the cleaning surface, the fiber aggregation is formed mainly by melting or bonding of the constituent fibers, and thus the results of the poor cleaning performances are obtained. In addition, from the comparison of Example 14 to Comparative Example 10, it can be seen that if there is no support supporting the fiber aggregation, the sheet elongation is increased and the cleaning sheet easily becomes longer, and thus it is not suited for use for a cleaning sheet.

[0176]

Comparing Examples 6, 7 and 8, it can be seen that Example 6 in which the number of the long fiber ends (the number of the long fiber ends per 10 cm² of fiber-raising treatment surface) is the maximum has the result of the most excellent

cleaning performance, and thus cleaning performance is more improved as the number of the long fiber ends becomes larger. In particular, from the comparison of Example 7 to Example 8, it can be seen that when the number of the long fiber ends is more than 10, the hair-catching property is improved.

5 [0177]

Comparing Examples 9, 10, 11 and 12, although all of them have the good cleaning performances, because the fiber aggregation mainly includes the constituent fibers having a fiber size of less than 8 μm in Example 12, the wiping resistance is high, thus resulting in slightly poor feel of wiping. In Example 9, because, mainly, there is the fiber aggregation having a ratio of the fibers with a fiber size of more than 45 μm to the all of the fibers of 50% by mass or more, the degree of dropping-off of fibers is slightly high, thus resulting in appearance of so-called fiber dropping-off when cleaned. For this result, as for the fiber aggregation, it is preferable that the ratio of the constituent fibers having a fiber size (diameter) of 8 μm or more and 45 μm or less (more preferably 10 μm or more and 40 μm or less) to all of the constituent fibers is 50% by mass or more, in terms of the decrease of the wiping resistance and the fiber dropping-off. Additionally, Example 9 has a result in which the fiber dropping-off is observed, and Example 12 has a result of slightly poor feel of wiping, but both of Example 9 and 12 reach the level in which they can be sufficiently used as the cleaning sheet.

[0178]

Comparing Example 6 and Example 14, though both of them have the good cleaning performance, a results in which despite that they are produced through the same fiber-raising treatment, Example 6 having protrusions and recesses on its fiber-raising treatment has more number of the long fiber ends than Example 14 having substantially no protrusions and recesses, thus resulting in the higher hair-catching property and larger particulate garbage-catching property. For this result, it can be seen that the uneven fiber-raising treatment surface is effective for the increase of the number of the long fiber ends and the improvement of cleaning performance.

30 [0179]

Additionally, as for the cleaning sheet having the protrusions and recesses (the samples of Examples 6 to 8, 10, 11 and 13, and Comparative Example 7), it is confirmed that the larger particulate garbage-catching property is evaluated as the mass ratio of the particulate garbage caught in the recesses : that on the protrusions = about 5:1 in the all cases, and the particulate garbage is preferentially caught in the recesses, and it is confirmed that in the evaluation of the hair-catching property, the hair is caught on the protrusions so that it is entangled with the protrusions.

Industrial Applicability

[0180]

When the composite sheet of the present invention is used for the cleaning sheet, the hair and the garbage such as cotton dust can be further efficiently caught, and the particulate garbage can be sufficiently caught.

[0181]

The cleaning sheet of the present invention shows the excellent catching property and holding property to hair or garbage such as dust regardless of whether the surface to be cleaned or the garbage is dry or wet, and it is difficult to cause the dropping-off of the constituent fibers.

CLAIMS

1. A composite sheet comprising a nonwoven-fabric-like fiber aggregation, and a mesh sheet or a thermally bonded non-woven fabric as a framework material, the fiber aggregation is integrated to one or both sides of the mesh sheet or the thermally bonded non-woven fabric in a state in which fibers forming the fiber aggregation are entangled with each other and with the framework material,

the composite sheet being formed into a three-dimensional uneven shape so as to have a plurality of protrusions and recesses,

the constituent fibers of the fiber aggregation being raised from the surfaces of the protrusions and the recesses,

a ratio of a number of the constituent fibers which are raised from the surfaces of the recesses and have a height of 1 mm or more to a number of the constituent fibers which are raised from the surfaces of the recesses and have a height of 0.1 mm or more being 25% or more, and

an average height of the constituent fibers raised from surfaces of the recesses is higher than an average height of the constituent fibers raised from surfaces of the protrusions.

2. The composite sheet according to claim 1, wherein a ratio (h_3/h_2) of the average height (h_3) of the constituent fibers raised in the recesses to the average height (h_2) of the constituent fibers raised in the protrusions is 3 or less.

3. The composite sheet according to claim 1 or 2, wherein the average height of the constituent fiber raised in the recess is from 0.5 to 30 mm, and the number of the constituent fibers raised in the recess is from 5 to 80 fibers/10 mm width.

4. The composite sheet according to any one of claims 1 to 3, wherein a material forming the framework material has the lowest melting point among the fiber materials forming the composite sheet.

5. The composite sheet according to any one of claims 1 to 4, wherein the fiber aggregation is formed by mixing two or more kinds of constituent fibers whose

diameters differ from each other by double or more.

6. The composite sheet according to any one of claims 1 to 5, which is used for a cleaning sheet.

7. The composite sheet according to any one of claims 1 to 6, wherein a ratio (h_3/h_2) of the average height (h_3) of the constituent fibers raised in the recesses to the average height (h_2) of the constituent fibers raised in the protrusions is 2 or less.

8. The composite sheet according to any one of claims 1 to 7, wherein a ratio of the constituent fibers raised in the recesses and having a raising height of 1 mm or more to the constituent fibers raised in the recesses is from 30 to 95%, and

a ratio of the constituent fibers raised in the protrusions and having a raising height of 1 mm or more to the constituent fibers raised in the protrusions is from 20 to 90%.

9. The composite sheet according to any one of claims 1 to 8, wherein the constituent fibers raised include fibers raised in the state in which a fiber end protrudes, and loop-shaped fibers raised, and

a ratio of the loop-shaped fibers raised to the constituent fiber raised is from 2 to 70%.

10. A method for manufacturing the composite sheet according to claim 1, comprising:

performing a fiber-raising processing in which the constituent fibers of the composite sheet are raised; and then

subjecting a plurality of parts of the composite sheet which has been subjected to the fiber-raising processing to an uneven shape-providing processing so that a plurality of protrusions and recesses are formed on the composite sheet.

11. The method for manufacturing the composite sheet according to claim 10, wherein the fiber-raising processing is performed using a protrusion roll having a plurality of protrusions on its peripheral surface, and

the composite sheet is supplied to the protrusion roll and the constituent fibers of the fiber aggregation which forms the composite sheet are raised.

12. The method for manufacturing the composite sheet according to claim 10 or 11, wherein

5 the uneven shape-providing processing is performed using a pair of uneven rolls,

10 one roll of the uneven rolls has a plurality of protrusions on its peripheral surface, and the other roll of the uneven rolls has a plurality of recesses, into which the protrusions of the former roll are inserted, at locations corresponding to the protrusions of the former roll on its peripheral surface,

 a space is formed between the apex part of the protrusion on the one roll and the bottom part of the recess in the other roll, and

15 the composite sheet which has been subjected to the fiber-raising processing is supplied to between a pair of the uneven rolls, and uneven shapes are provided to a plurality of parts of the composite sheet which has been subjected to the fiber-raising processing.