fiber aggregate. The hydrophobic fiber aggregate has its constituent fibers entangled with one another, entering the hydrophilic fiber aggregate, and entangled with fibers constituting the hydrophilic fiber aggregate in a way that the hydrophilic fiber aggregate and the hydrophobic fiber aggregate are united together. The cleaning sheet is three-dimensionally textured with a plurality of protrusions and a plurality of depressions on both sides thereof in a pattern such that protrusions on one side correspond to depressions on the other side and that depressions on one side correspond to protrusions on the other side. The cleaning sheet has a linear bond where the hydrophilic fiber aggregate and the hydrophobic fiber aggregate are bonded to each other.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a perspective view of an embodiment of the cleaning sheet according to the invention.

[Fig. 2] Fig. 2 is a developed perspective view of the cleaning sheet shown in Fig. 1.

[Fig. 3] Fig. 3 is a cross-sectional view taken along line I-I in Fig. 1.

[Fig. 4] Fig. 4 is an enlarged cross-sectional view of an essential part of the cleaning sheet shown in Fig. 1.

[Fig. 5] Fig. 5 schematically illustrates a method for counting the number, and measuring the height, of raised constituent fibers.

[Fig. 6] Fig. 6 illustrates measurement of the height of raised constituent fibers using a digital microscope in a vertical mode.

[Fig. 7] Fig. 7 is a schematic illustration of an apparatus suited to produce the cleaning sheet of Fig. 1.

[Fig. 8] Fig. 8 is a schematic perspective view of a raising part of the processing apparatus shown in Fig. 7.

[Fig. 9] Fig. 9 is schematic cross-sectional view of a texturing part of the processing apparatus shown in Fig. 7.

[Fig. 10] Fig. 10 is an enlarged cross-section view of an essential part of the texturing part shown in Fig. 9.

[Fig. 11] Fig. 11 is a schematic perspective view of a bonding part shown in Fig. 7.

[Fig. 12] Fig. 12 illustrates a cleaning implement used with the cleaning sheet of the invention.

Description of Embodiments

[0010]

The cleaning sheet of the invention will be described based on its preferred embodiments with reference to the accompanying drawings. Fig. 1 shows an embodiment of the cleaning sheet of the invention. Fig. 2 represents a developed perspective view of the cleaning sheet of Fig. 1. Figs. 3 and 4 are cross-sectional views of the cleaning sheet of Fig. 1. A cleaning sheet 1 of the present embodiment (hereinafter also simply referred to as "cleaning sheet 1") includes a hydrophilic fiber aggregate 11 composed mainly of hydrophilic fibers, and a hydrophobic fiber aggregate 12 composed mainly of hydrophobic fibers and disposed on both sides 11a and 11b of the hydrophilic fiber aggregate 11. The hydrophobic fiber aggregate 12 has its constituent fibers 14 entangled with one another, entering the hydrophilic fiber aggregate 11, and entangled with fibers 13 constituting the hydrophilic fiber aggregate 11 in a way that the hydrophilic fiber aggregate 11 and the hydrophobic fiber aggregate 12 are united together to form the cleaning sheet 1. The thus formed cleaning sheet 1 has the hydrophilic fiber aggregate 11 of nonwoven fabric form located in the inside in the thickness direction thereof and the hydrophobic fiber aggregate 12 of fiber layer form located on each of a first side 1a thereof and a second side 1b opposite to the first side la. As shown in Fig. 4, the hydrophobic fiber aggregate 12 has its constituent fibers 14 entangled with one another and also has its constituent fibers 14 entering the inside of the hydrophilic fiber aggregate 11 and entangled with the fibers 13 making up the hydrophilic fiber aggregate 11. Thus, the hydrophilic fiber aggregate 11 and the hydrophobic fiber aggregates 12 are united into consolidated nonwoven fabric. The cleaning sheet 1 is what we call a dry cleaning sheet that is not intentionally impregnated with a liquid, such as a cleansing liquid. The developed perspective view of Fig. 2 is intended to illustrate the structure composed of the hydrophilic fiber aggregate 11 and the hydrophobic fiber aggregates 12 disposed on the sides 11a and 11b of the hydrophilic fiber aggregate 11 but not to show the three fiber aggregates delaminated from each other.

[0011]

The cleaning sheet 1 has both a raised fiber a free end of which sticks out and a raised fiber having a loop form (hereinafter also referred to as a raised loop fiber). In detail, the cleaning sheet 1 has more raised fibers 14 raised from the surface of the depressions 2 (raised fibers of the depressions 3) than those raised from the surface of the protrusions 2 (raised fibers of the protrusions 2). The number of the raised fibers 14 (the number of the raised fibers) is the number of raised fibers sticking out of the surface of the protrusions 2 or the depressions 3 in a natural state of the cleaning sheet 1 and does not include the number of raised fibers 14 drawn or pulled out from then surface of the protrusions 2 or the depressions 3. As will be described in detail with respect to the method for making the cleaning sheet 1, raising is carried out before three-dimensional texturing. Therefore, the degree of raising (e.g., the number of raised fibers) is uniform immediately after the raising process. However, as will be described later, the method for making the cleaning sheet 1 involves, after the raising process, the steps of texturing, taking up the textured sheet into roll, and further processing to provide a stack of finished products. During these steps, the raised fibers 14 located on the protrusions 2 are collapsed, whilst the raised fibers 14 located in the depressions 3 retain the raised state. As a result, the cleaning sheet 1 in its natural state has a larger number of apparent raised fibers 14 located in the depressions 3 as drawn in Fig. 3.

[0022]

The height (h2) of the raised fiber 14 on the protrusion 2 (the raised fiber of the protrusion 2) is preferably 0.1 mm or more, more preferably 0.5 mm or more, and 30 mm or less, more preferably 20 mm or less. The height (h3) of the raised fiber 14 in the depression 3 (the raised fiber of the depression 3) is preferably 0.1 mm or more, more preferably 0.5 mm or more, and 30 mm or less, more preferably 20 mm or less.

[0023]

The number of the raised fibers 14 on the protrusion 2 (the raised fibers of the protrusion 2) is preferably 5 or greater, more preferably 10 or greater, and 80 or fewer, more preferably 70 or fewer, per 10 mm width. The number of the raised fibers 14 in the depression 3 (the raised fibers of the depression 3) is more than 5, preferably 10 or greater, and 100 or fewer, more preferably 90 or fewer, per 10 mm width.

The arrangement between the raised fibres on a protrusion 2 and the raised fibres on a depression 3 always being such that the cleaning sheet 1 has more raised fibers 14 on the surface of the depressions 3 (raised fibers of the depressions 3) than on the surface of the protrusions 2 as shown in Fig. 3. The effect of having more raised fibers in the depressions 3 than on the protrusions 2 is that dust trapped in the depressions is more easily entangled with the raised fibers and retained there during a cleaning operation.
The height and number of the raised fibers 14 are measured by the method below.

[0024]
Preparation of sample:

Two samples large enough (about 60 to 70 mm in the CD and about 50 mm in the MD) to allow for observation over a measuring length of 50 mm are cut out of the cleaning sheet 1. Each sample is folded into halves in a direction perpendicular to the MD and fixed on a sheet of black paper as shown in Fig. 5. The folding line should be at such a position that allows an observer to see the profile of the surface texture of the sample. Such a folding line passes almost the center of a plurality of protrusions and a plurality of depressions. The folded edge is lightly brushed five times using a brush (general-purpose brush No. 812 30 mm available from Komeri Co., Ltd.) in a direction from the sample to the black paper to make the raised fibers easily observable. The brushing force applied during brushing to the area 93 to be observed is controlled within a range of from 5 to 15 gf. The brushing force is adjusted by reference to the readings of a measuring scale.

[0025]
Measurement of number and height of raised fibers:

The sample folded in halves is observed using a digital microscope (VHX-500 from Keyence) at a magnification of 20 times. Measurement is taken using a vertical mode of measurements modes of the digital microscope as shown in Fig. 6. After a baseline of a protrusion 2 or a valley (depression 3) is obtained, the height of the highest point of every raised fiber 14 is measured within the respective measuring ranges of the protrusion 2 and the depression 3. The height is measured to about tenths of a 30 millimeter, and measured values of 0.1 mm or greater are collected. Measurement is taken on at least two samples ($n \geq 2$). The height and the number are measured of the raised fibers on all protrusions 2 and depressions 3 existing in the measuring length of

as a rubber or sand roller having rubber or sand paper around its peripheral surface, may also be used. The formation of a laminate 6 (a precursor of the cleaning sheet 1) in the joining part 20A and entanglement part 20B, the raising in the raising part 20E, and the deformation in the texturing part 20D and bonding part 20E may be performed either continuously or discontinuously.

[0082]

In making the cleaning sheet 1, the hydrophilic fiber aggregate 11 taken off the stock roll 23 as shown in Fig. 7 has the form of nonwoven fabric. Instead of this, a continuous fiber web may be used. In such a case, an additional card is installed between the cards 21A and 21B, and a carded fiber web from the additional card is continuously fed as a hydrophilic fiber aggregate 11.

[0083]

The following clauses relative to the foregoing embodiments for the cleaning sheet and the method for making the cleaning sheet are disclosed below.

[0084]

(1) A cleaning sheet comprising a hydrophilic fiber aggregate composed mainly of hydrophilic fibers, and a hydrophobic fiber aggregate composed mainly of hydrophobic fibers and arranged on both sides of the hydrophilic fiber aggregate, the hydrophobic fiber aggregate having its constituent fibers entangled with one another, entering the hydrophilic fiber aggregate, and entangled with fibers constituting the hydrophilic fiber aggregate in a way that the hydrophilic fiber aggregate and the hydrophobic fiber aggregate are united together,

the cleaning sheet being three-dimensionally textured with a plurality of protrusions and a plurality of depressions on both sides thereof in a pattern such that protrusions on one side correspond to depressions on the other side and that depressions on one side correspond to protrusions on the other side, and

the cleaning sheet having a linear bond where the hydrophilic fiber aggregate and the hydrophobic fiber aggregate are bonded to each other.

[0085]

CLAIMS

1. A cleaning sheet comprising a hydrophilic fiber aggregate composed mainly of hydrophilic fibers, and a hydrophobic fiber aggregate composed mainly of hydrophobic fibers and arranged on both sides of the hydrophilic fiber aggregate, the hydrophobic fiber aggregate having its constituent fibers entangled with one another, entering the hydrophilic fiber aggregate, and entangled with fibers constituting the hydrophilic fiber aggregate in a way that the hydrophilic fiber aggregate and the hydrophobic fiber aggregate are united together,

the cleaning sheet being three-dimensionally textured with a plurality of protrusions and a plurality of depressions on both sides thereof in a pattern such that protrusions on one side correspond to depressions on the other side and that depressions on one side correspond to protrusions on the other side,

the cleaning sheet having a linear bond where the hydrophilic fiber aggregate and the hydrophobic fiber aggregate are bonded to each other,

the cleaning sheet has raised fibers raised from the surface of the protrusions and the surface of the depressions, and

the number of raised fibers raised in the individual depressions is larger than the number of raised fibers raised in the individual protrusions.

2. The cleaning sheet according to claim 1, wherein the raised fiber raised in the individual depressions has a height of 0.1 to 30 mm, and the number of the raised fibers raised in the depressions is 5 to 100 per 10 mm width.

3. The cleaning sheet according to claim 1 or 2, wherein the linear bond intersects an imaginary line connecting the tops of two protrusions adjacent to each other at the shortest distance.

4. The cleaning sheet according to any one of claims 1 to 3, wherein the individual protrusions have a plan view area of 1 to 100 mm^2, and the linear bond has a bonding width of 0.3 to 5 mm.

5. The cleaning sheet according to any one of claims 1 to 4, wherein the hydrophilic fiber aggregate has a larger basis weight than the hydrophobic fiber aggregate per side.

6. The cleaning sheet according to any one of claims 1 to 5, wherein the raised fibers located on the protrusions are collapsed, and the raised fibers located in the depressions retain the raised state.

7. A method for making the cleaning sheet according to claim 1, comprising the steps of superposing the hydrophobic fiber aggregate on each side of the hydrophilic fiber aggregate to make a stack, entangling the fibers of the hydrophilic fiber aggregate and the fibers of the hydrophobic fiber aggregate by applying high-pressure water jets to each side of the stack to unite the stack into a laminate, subjecting the laminate to raising on both sides thereof, texturing a plurality of regions of the raised laminate with protrusions and depressions, and seal bonding the textured laminate to form a linear bond at which the hydrophilic fiber aggregate and the hydrophobic fiber aggregates are bonded together.