

## DESCRIPTION

TITLE OF THE INVENTION: WET WIPING SHEET

5 FIELD OF THE INVENTION

{0001}

The present invention relates to a wet wiping sheet.

10 BACKGROUND OF THE INVENTION

{0002}

As products long used on a daily basis, wet wiping sheets such as cleaning wipers and hygiene items have been steadily enhanced in performance through vigorous studies aimed at meeting performance demands. For example, in order to improve wiping performance, frictional resistance and heat resistance, a proposal has been made on a material containing liquid crystal polyester in 50% by mass or more, which is fibrillated to 0.5  $\mu\text{m}$  or less in fiber diameter in a surface layer portion (see Patent Literature 1). Regarding another aspect, since fiber density is high in a first layer closest to an absorbent body, a large amount of liquid discharged onto a topsheet cannot be easily led to the absorbent body. Therefore, a proposal has been made on use of a nonwoven fabric that when liquid permeates therethrough exhibits low diffusibility, without inhibiting liquid movement from the topsheet to the absorbent body (see Patent Literature 2).

25 CITATION LIST

PATENT LITERATURES

{0003}

Patent Literature 1:JP-A-2013-159887("JP-A" means unexamined published

Japanese patent application)

Patent Literature 2: JP-A-2008-144322

## SUMMARY OF THE INVENTION

### 5 TECHNICAL PROBLEM

{0004}

The present invention provides a wet wiping sheet, containing a fiber aggregate of at least two kinds of fibers having different fiber diameters,

wherein the wet wiping sheet has a first surface and a second surface on  
10 a side opposite to the first surface;

wherein the at least two kinds of fibers having different fiber diameters are entangled with each other,

wherein proportion of fibers having a small fiber diameter present in the fiber aggregate is larger on the first surface side than on the second surface side,  
15 proportion of fibers having a large fiber diameter present in the fiber aggregate is larger on the second surface side than on the first surface side, and capillary pressure on the first surface side is higher than the capillary pressure on the second surface side, and

wherein a wiping liquid is charged into at least the fiber aggregate on the  
20 second surface side.

{0005}

Other and further objects, features and advantages of the invention will appear more fully from the following description, appropriately referring to the accompanying drawings.

25

## BRIEF DESCRIPTION OF DRAWINGS

{0006}

{FIG. 1}

FIG. 1 is a photograph substituted for drawing, which is obtained by picking up an image of a first surface of surfaces of a wet wiping sheet of the present invention by using a scanning electron microscope.

{FIG. 2}

5           FIG. 2 is a photograph substituted for drawing, which is obtained by picking up an image of a second surface of surfaces of a wet wiping sheet of the present invention by using a scanning electron microscope.

{FIG. 3}

10           FIG. 3 is a photograph substituted for drawing, which is obtained by picking up an image of part of a cross section of a wet wiping sheet of the present invention by using a scanning electron microscope.

{FIG. 4}

15           FIG. 4 is a photograph substituted for drawing, which is obtained by picking up an image of another part of a cross section of a wet wiping sheet of the present invention by using a scanning electron microscope.

{FIG. 5}

FIG. 5 is a photograph substituted for drawing, which is obtained by picking up an image of part of a cross section of a produced typical wet wiping sheet of the present invention by using a scanning electron microscope.

20           {FIG. 6}

FIG. 6 is a graph obtained by measuring a liquid release amount (g) per jo and a wiping area (jo), and plotting the measured values in a produced typical wet wiping sheet of the present invention.

{FIG. 7}

25           FIG. 7 is a photograph substituted for drawing, showing a first surface of a produced typical wet wiping sheet of the present invention.

## DESCRIPTION OF EMBODIMENTS

{0007}

The present inventors conducted studies on conventional technologies, including the proposals described above. In a conventional wet wiping sheet containing a wiping liquid, the wiping liquid is released onto a wiping surface in an amount that is more than necessary per wipe-off of dirt from the wiped surface (per wiping). The present inventors therefore realized that there is room for further improvement. In particular, a problem arises when the dirt can be removed only by strongly scrubbing the surface. That is, the wiping liquid is released onto a wiped surface in an amount that is more than necessary for wiping off the dirt on the wiped surface. Therefore, in the case of wiping a surface having a large wiping area, such as the surface of a rug, carpet, floor or the like, the number of times the wet wiping sheet needs to be replaced with a new one becomes large.

{0008}

Accordingly, the present invention relates to a wet wiping sheet capable of removing dirt by lightly wiping a surface, without being changed or with only a few changes, even if area is large.

{0009}

The present inventors conducted studies on various means for preventing release of the wiping liquid onto the wiped surface in an amount greater than necessary for wiping off the dirt on the wiped surface, particularly when the surface is strongly scrubbed. As a result, as mentioned above, the present inventors found that the above-described problems can be solved by using at least two kinds of fibers having different fiber diameters, and by controlling state of fibers having a small fiber diameter present and a capillary pressure, and completed the present invention based on this finding. "Wiping" as termed in the present invention is used in a broad sense of general wiping, including both surface cleaning and bed bathing. For example, the term covers various aspects

of building cleaning, such as cleaning of floor surface, wall surface, ceiling and pillar, cleaning of fixtures and equipment, wiping of articles, various aspects of bed bathing and cleaning of items used for bed bathing, as well as various other kinds of wiping and cleaning.

5 {0010}

The present invention can provide the wet wiping sheet capable of removing dirt by lightly wiping the surface, without being changed or with only a few changes, even if area is large.

Hereinafter, the wet wiping sheet of the present invention and a method  
10 of producing the same will be described on the basis of preferred embodiments thereof.

First, the wet wiping sheet will be described.

{0011}

<<Wet wiping sheet>>

15 The wet wiping sheet of the present invention has a first surface and a second surface being a surface opposite to the first surface. That is, in the surfaces forming a front and a back of the wet wiping sheet, one surface (for example, a front surface) is taken as the first surface, and the other surface (for example, a back surface) is taken as the second surface. Hereinafter, the first  
20 surface will be described as a wiping surface, for example. The wiping surface means the surface from which the wiping liquid is released. The wet wiping sheet is formed of a fiber aggregate of at least two kinds of the fibers having different fiber diameters, in which the at least two kinds of fibers having different fiber diameters are entangled with each other. On a first surface side and a second  
25 surface side, at least the fibers having the small fiber diameter, of the at least two kinds of fibers having different fiber diameters (thick fibers and fibers thinner than the thick fibers), are present. In the fiber aggregate, the proportion of the fibers having the small fiber diameter present, of the above-described fibers having two

kinds of fiber diameters, is larger on the first surface side than on the second surface side (see FIG. 1). Moreover, in the fiber aggregate, the proportion of fibers having a large fiber diameter present is larger on the second surface side than on the first surface side (see FIG. 2). Moreover, the capillary pressure on the first surface side is higher than the pressure on the second surface side. Further, at least the wiping liquid is charged into the fiber aggregate on the second surface side.

{0012}

In addition, the above-described fiber aggregate is the fiber aggregate formed into a composite mainly with entanglement of the fibers with each other. Moreover, an expression “at least the wiping liquid on is charged into the fiber aggregate on the second surface side” means an aspect in which the wiping liquid is contained on the fiber aggregate on the second surface side, also including an aspect in which the wiping liquid is contained also on the fiber aggregate on, as well as the second surface side, the first surface side in voids thereof. As an amount of charging the wiping liquid, an amount of charging the liquid into the fiber aggregate on the second surface side is preferably larger than an amount of charging the liquid into the fiber aggregate on the first surface side.

{0013}

First, the present embodiment will be described by using scanning electron microscope (SEM) photographs of wet wiping sheets of the present invention on the basis of FIGs. 1 to 4 in drawings.

FIGs. 3 and 4 show photographs obtained by picking up images of different parts of cross sections prepared by cutting, using a cutter, the wet wiping sheet of the present invention. Both show that the fiber aggregate formed of the fibers having the small fiber diameter is present on an upper side of the figures, and the surface on the upper side serves as the first surface (front surface). Accordingly, a surface on a lower side of the figures serves as the second

surface (back surface).

{0014}

As shown in FIG. 1, when the first surface of the wet wiping sheet of the present invention is observed from above by using a scanning electron  
 5 microscope, an aggregate formed of the fibers having the small fiber diameter and the fibers having the large fiber diameter are confirmed. On the first surface of the wet wiping sheet, the fibers having the small fiber diameter are present in an amount larger than the fibers having the large fiber diameter. As is apparent also from FIG. 1, the wet wiping sheet contains, on a whole surface of the first  
 10 surface, the fibers having the large fiber diameter in the fiber aggregate formed of the fibers having the small fiber diameter, and not in the form of the fiber aggregate formed of only the fibers having the small fiber diameter.

On the other hand, as shown in FIG. 2, when the second surface of the wet wiping sheet of the present invention is observed from above by using the  
 15 scanning electron microscope, an aggregate of the fibers having the large fiber diameter and the fibers having the small fiber diameter are confirmed. On the second surface of the wet wiping sheet, the fibers having the large fiber diameter are present in an amount larger than the fibers having the small fiber diameter. As is apparent also from FIG. 2, the wet wiping sheet contains, on a whole  
 20 surface of the second surface, the fibers having the small fiber diameter in the fiber aggregate formed of the fibers having the large fiber diameter, and not in the form of the fiber aggregate formed of the fibers having the large fiber diameter.

In addition, in FIGs. 1 and 2, an observation range using the scanning electron microscope is  $290\ \mu\text{m} \times 380\ \mu\text{m}$  and a portion is magnified at a  
 25 magnitude of 330 times. In FIGs. 3 and 4, the observation range using the scanning electron microscope is  $170\ \mu\text{m} \times 240\ \mu\text{m}$  and a portion is magnified at a magnitude of 500 times.

{0015}

## &lt;Fibers&gt;

The fibers constituting the fiber aggregate in the present invention are at least two kinds of the fibers having different fiber diameters. As the fibers, fibers of polyester, polyamide, polyolefin or cellulose, or fibers prepared by using various metals, glass or mineral as a raw material are typical. Among the materials, fibers of polyester, polyamide, polyolefin or cellulose are preferable.

{0016}

The polyester may be any polyester as long as the polyester has a structure having an ester bond in a polymer main chain. Examples thereof include polyethylene terephthalate (PET), polytrimethylene terephthalate (PTT), polybutylene terephthalate (PBT), polyethylene naphthalate (PEN), and polybutylene naphthalate (PBN).

{0017}

The polyolefin is a material obtained from a monomer having an ethylenically unsaturated group. Examples thereof include polyethylene, polypropylene, an ethylene-propylene copolymer, polyvinyl acetate, an ethylene-vinyl acetate copolymer, cyclic acetal of polyvinyl alcohol, an acrylic resin (including an acrylic resin and a methacrylic resin) and polyvinyl chloride.

As described above, the polyolefin may be a homopolymer or a copolymer.

{0018}

The polyamide may be any polyamide as long as the polyamide has a structure having an amide bond in a polymer main chain. Examples thereof include a polycondensed nylon, such as Nylon-6, Nylon-11, and Nylon-12; and a co-polymerized nylon, such as Nylon-66, Nylon-610, Nylon-612, Nylon-6T, Nylon-6I, Nylon-9T, and Nylon-M5T. Moreover, examples thereof include polyamide obtained from a diamine component and a dicarboxylic acid component as described below.

{0019}

Examples of the diamine component include an aliphatic diamine compound such as tetramethylenediamine, pentamethylenediamine, 2-methylpentanediamine, hexamethylenediamine, heptamethylenediamine, 5 octamethylenediamine, nonamethylenediamine, decamethylenediamine, dodecamethylenediamine, 2,2,4-trimethyl-hexamethylenediamine and 2,4,4-trimethylhexamethylenediamine. Examples thereof also include an alicyclic diamine compound such as 1,3-bis(aminomethyl)cyclohexane, 1,4-bis(aminomethyl)cyclohexane, 1,3-diaminocyclohexane, 1,4-diaminocyclohexane, 10 bis(4-aminocyclohexyl)methane, 2,2-bis(4-aminocyclohexyl)propane, bis(aminomethyl)decalin and bis(aminomethyl)tricyclodecane. Examples thereof further include a diamine compound having an aromatic ring, such as metaxylylenediamine, paraxylylenediamine, bis(4-aminophenyl)ether, paraphenylenediamine and bis(aminomethyl)naphthalene.

15 {0020}

Examples of the carboxylic acid component include an aliphatic dicarboxylic acid compound such as succinic acid, glutaric acid, pimelic acid, suberic acid, azelaic acid, adipic acid, sebacic acid, undecanedioic acid and dodecanedioic acid. Examples thereof also include a phthalic acid compound 20 such as isophthalic acid, terephthalic acid and orthophthalic acid. Examples thereof further include a naphthalenedicarboxylic acid compound such as 1,2-naphthalenedicarboxylic acid, 1,3-naphthalenedicarboxylic acid, 1,4-naphthalenedicarboxylic acid, 1,5-naphthalenedicarboxylic acid, 1,6-naphthalenedicarboxylic acid, 1,7-naphthalenedicarboxylic acid, 1,8-naphthalenedicarboxylic acid, 1,7-naphthalenedicarboxylic acid, 1,8-naphthalenedicarboxylic acid, 2,3-naphthalenedicarboxylic acid, 2,6-naphthalenedicarboxylic acid and 2,7-naphthalenedicarboxylic acid.

{0021}

The above-described diamine components and dicarboxylic acid

components, including the nylons, may be used alone or in combination thereof, respectively.

{0022}

The cellulose fibers may be natural fibers or synthetic fibers, and  
5 examples of the synthetic fibers include acylate fibers such as cellulose acetate.

{0023}

Moreover, examples of the mixed fibers include  
polyethylene/polyethylene terephthalate, and polypropylene/polyethylene  
terephthalate.

10 {0024}

In the present invention, among the above-described fibers, polyethylene  
terephthalate, polypropylene, an acrylic resin, nylons and cellulose fibers are  
more preferable. As the acrylic resin, a material having a repeating unit obtained  
from acrylic acid or ester thereof, or methacrylic acid or ester thereof is  
15 particularly preferable.

{0025}

A fiber length of the fibers, namely, a mean fiber length of the fibers as a  
whole to be used in the present invention is preferably 1 mm or more and 100  
mm or less, more preferably 10 mm or more and 90 mm or less, and further  
20 preferably 20 mm or more and 60 mm or less.

{0026}

Between the fiber diameters of the fibers having different fiber diameters,  
a difference between the fiber diameter of thin fibers and the fiber diameter of  
thick fibers is preferably 1  $\mu\text{m}$  or more and 29.9  $\mu\text{m}$  or less, more preferably 2  $\mu\text{m}$   
25 or more and 28  $\mu\text{m}$  or less, and further preferably 5  $\mu\text{m}$  or more and 27  $\mu\text{m}$  or  
less from a viewpoint of providing the fibers with a difference in the capillary  
pressure as mentioned later.

Moreover, among the fibers having different fiber diameters, the fiber

diameter of the thin fibers is preferably 0.1  $\mu\text{m}$  or more and 9  $\mu\text{m}$  or less, more preferably 0.3  $\mu\text{m}$  or more and 7  $\mu\text{m}$  or less, and further preferably 0.5  $\mu\text{m}$  or more and 5  $\mu\text{m}$  or less. Among the fibers having different fiber diameters, the fiber diameter of the thick fibers is preferably 10  $\mu\text{m}$  or more and 30  $\mu\text{m}$  or less, more preferably 11  $\mu\text{m}$  or more and 28  $\mu\text{m}$  or less, and further preferably 15  $\mu\text{m}$  or more and 25  $\mu\text{m}$  or less. The fibers having the small fiber diameter and the fibers having the large fiber diameter are selected according to a wiping function.

{0027}

The fibers having different fiber diameters may be fibers having components which are the same with or different from each other, but are preferably the fibers having the same component in the present invention. Moreover, the fiber length may be the same with or different from each other in the fibers, but in the present invention, the fibers having the same fiber length are preferable.

{0028}

In the present invention, at least two kinds of the fibers having different fiber diameters are entangled with each other. A proportion of the fibers having the small fiber diameter present is larger on the first surface side than on the second surface side, and a proportion of the fibers having the large fiber diameter present is larger on the second surface side than on the first surface side, and the capillary pressure on the first surface side is higher than the capillary pressure on the second surface side. Thus, an amount of the wiping liquid released for wiping off the dirt on the wiped surface can be controlled to a required amount, even if the surface is strongly wiped upon wiping the surface. Therefore, even in the case of wiping of a wide wiping area, such as a rug, carpet, floor and the like, the wet wiping sheet needs not to be exchanged for the new wet wiping sheet during wiping the surface, or the number of exchanges can be reduced. A proportion of the “fibers having the small fiber diameter” to the “fibers having the large fiber

diameter” may be in any range as long as a difference is produced in the capillary pressure, and can be appropriately set depending on an application of the wiping sheet, a use pattern or the like, and is not primarily determined.

<Measurement method of proportion of fibers>

5           The number of fibers having the large fiber diameter and the number of fibers having the small fiber diameter in the range of 290  $\mu\text{m}$   $\times$  380  $\mu\text{m}$  in the visual field range is measured by magnifying the fibers at a magnification of 330 times by using the scanning electron microscope, and then respective proportions are derived therefrom. As mentioned above, fibers having a fiber diameter of 9  
10  $\mu\text{m}$  or less are taken as the fibers having the small fiber diameter, and fibers having a fiber diameter of 10  $\mu\text{m}$  or more are taken as the fibers having the large fiber diameter. The number is measured on arbitrary 20 points on a sheet surface in a similar manner, and this mean value is taken as each proportion of the fibers on the first surface and on the second surface.

15 {0029}

In general, it is known that the capillary pressure  $P_c$  follows the following relational expression.

{0030}

{Formula 1}

$$P_c = \frac{2\gamma_L \cos\theta}{r}$$

20

{0031}

The capillary pressure  $P_c$  derived from the above-described formula is a value using summary statistics derived from measurement of a nonwoven fabric. Here,  $P_c$  is a capillary pressure ( $\text{N/m}^2$ ) of the nonwoven fabric,  $\gamma_L$  is surface  
25 tension ( $\text{N/m}$ ) of the liquid,  $\theta$  is a contact angle (rad) between the fiber and the liquid, and  $r$  is a fiber diameter (m). Then,  $k$  is a correction coefficient in consideration of a factor such as a proportion of the voids per volume of the

nonwoven fabric and the like, and the capillary pressure can be determined more accurately by calibrating data with this correction coefficient.

{0032}

In order to measure  $P_c$ , it is necessary to measure the surface tension of the liquid, the fiber diameter, and the contact angle between the fiber and the liquid. The surface tension is determined as a mean value obtained by measuring the surface tension 10 times under an environment of 20°C and 65% R.H. by using an automatic surface tensiometer based on a plate method, such as DY-200 manufactured by Kyowa Interface Science Co., Ltd. The fiber diameter is determined, from observation using the scanning electron microscope, as a mean value obtained by measuring the fiber diameters of 30 fibers per observation in 5 places and 150 fibers in total at random at a magnification of 350 times. As the contact angle between the fiber and the liquid, constituent fibers of the nonwoven fabric are identified by using Fourier Transform Infrared Spectroscopy (FTIR), and the contact angle on a resin plate having the same composition is measured. Specifically, the contact angle when 3 seconds elapse after 1  $\mu$ L is added dropwise thereto is measured on 5 places on the plate by a fully automatic contact angle meter such as DMO-901 manufactured by Kyowa Interface Science Co., Ltd., and a mean value thereof is taken as the contact angle. In addition, when a plurality of materials of the fibers exist, the contact angle is measured for each material in a similar manner, and as a value during calculating  $P_c$ , a value obtained by performing weighted averaging of the contact angle based on a surface area ratio of each fiber component is taken as  $\theta$  in the formula.

{0033}

As is apparent also from the above-described formula, as the fiber diameter is reduced (lessened), the capillary pressure increases. In the present invention, the capillary pressure on the first surface side is increased by reducing

the fiber diameter. When the wiping liquid contained in the fiber aggregate on the first surface side is reduced or exhausted, the wiping liquid charged into the fiber aggregate on the second surface side is sucked into the fiber aggregate on the first surface side owing to the difference in the capillary pressure. Thus, an

5 appropriate amount of the wiping liquid is supplied to the fiber aggregate on the first surface side, and the first surface side is formed into a state in which the wiping liquid in an amount suitable for wiping the surface always exists therein.

{0034}

Moreover, among the surfaces of the wet wiping sheet, including the

10 voids, an area percentage of the fibers having the small fiber diameter on the first surface is preferably 40% or more and 99% or less, more preferably 45% or more and 95% or less, and further preferably 50% or more and 90% or less. On the other hand, the area percentage of the fibers having the small fiber diameter on the second surface is preferably 0% or more and 55% or less. An area of the

15 fibers having the small fiber diameter on the first surface is determined by measuring the area of the fibers having the small fiber diameter from an image obtained by picking up the image of the first surface or a photograph thereof, for example. Hereinafter, each area of the fibers can be determined in the same manner as described above. Accordingly, the area percentage becomes a value

20 obtained by dividing the area of the fibers by the area serving as a measurement target. In addition, in the case of expression as a percentage (%), the value becomes 100 times the divided value.

{0035}

Here, for example, remaining 1% other than 99% of the upper limit in the

25 above-described area percentage of 40% to 99% is the void. This void is necessary for the wiping liquid to be released onto the first surface. The amount of the wiping liquid to be released for wiping off the dirt on the wiped surface can be suppressed to the required amount, even if the surface is strongly wiped, by

adjusting the proportion of this void. Moreover, the area percentage of the fibers having the small fiber diameter on the second surface is adjusted to the percentage as described above, resulting in increasing the voids, and the amount of the wiping liquid charged increases. The wiping liquid is released in the appropriate amount by having the area percentage of the fibers having the small fiber diameter on the above-described first surface in the above-described lower limit or more, and therefore the wiping liquid is not released in an amount that is more than necessary. Therefore, an area which can be wiped increases.

{0036}

10 In the present invention, the area percentage of the fibers having the small fiber diameter on a surface in parallel with the first surface is preferably reduced stepwise, in a curved manner or in combination thereof toward a thickness direction on a side opposite to the first surface. In particular, the amount of the wiping liquid charged can be increased by adjusting the area

15 percentage of the fibers having the small fiber diameter to the range of 50% or more and 100% or less in 50% or more and 100% or less of a thickness of the wet wiping sheet from the second surface. Here, a percentage of the above-described thickness in which the area percentage of the fibers having the small fiber diameter is adjusted in the range of 50% or more and 100% or less is

20 preferably 1% or more and 90% or less, more preferably 5% or more and 70% or less, and further preferably 7% or more and 50% or less. In addition, the amount of the wiping liquid to be released for wiping off the dirt on the wiped surface can be released in the required amount by adjusting the range to a preferable percentage of the thickness as described above.

25 {0037}

Here, in order to obtain information inside the wet wiping sheet, a confocal laser microscope can be used. A spectrum inside a sample can be obtained by using the confocal laser microscope, and a component distribution

inside the sample can be observed nondestructively by performing Raman imaging of the sample in a depth direction, for example.

{0038}

In the present invention, the wet wiping sheet is formed of at least two  
 5 layers of a liquid holding layer in which the wiping liquid is charged, and a liquid release layer, and the liquid release layer includes the first surface. In particular, in order to charge a large amount of the wiping liquid, as described above, the area percentage of the fibers having the small fiber diameter is adjusted to 1% or more and 100% or less in 50% or more and 100% or less of the thickness of the  
 10 wet wiping sheet from the second surface. Thus, the liquid holding layer in which the large amount of the wiping liquid is charged can be formed. On the other hand, the liquid release layer is a portion including the first surface and other than the liquid holding layer.

{0039}

In the present invention, basis weight of the fibers is preferably 1 g/m<sup>2</sup> or more and 100 g/m<sup>2</sup> or less, more preferably 5 g/m<sup>2</sup> or more and 50 g/m<sup>2</sup> or less, and further preferably 10 g/m<sup>2</sup> or more and 30 g/m<sup>2</sup> or less on the first surface side. On the other hand, on the second surface side, it is preferably 10 g/m<sup>2</sup> or more and 50 g/m<sup>2</sup> or less, more preferably 15 g/m<sup>2</sup> or more and 30 g/m<sup>2</sup> or less,  
 20 and further preferably 20 g/m<sup>2</sup> or more and 25 g/m<sup>2</sup> or less.

{0040}

In the present invention, it is particularly preferable that the fibers having different fiber diameters are entangled with each other without being thermally fused to each other. Thus, the voids between the fibers increase, and the  
 25 amount of the wiping liquid charged increases, in comparison with a case where the fibers are thermally fused.

{0041}

In the wet wiping sheet of the present invention, the wiping liquid is

released from the first surface to the wiped surface per wiping, more specifically, by wiping the wiped surface once. A release amount of the wiping liquid for each of wiping the surface once is preferably 0.5 g/jo or more, more preferably 0.7 g/jo or more, and further preferably 1.0 g/jo or more. An upper limit of the amount to be released is practically 8 g/jo or less, preferably 7 g/jo or less, and more preferably 6 g/jo or less. The surface can be sufficiently wiped off by having the above-described release amount in the above-described lower limit or more, and a remaining wiping liquid becomes hard to be caused on the first surface by having the release amount in the above-described upper limit or less. Here, the term “jo” means a unit having a size of 1820 mm × 910 mm and an area of 1.6552 m<sup>2</sup>.

{0042}

FIG. 6 is a graph showing the results obtained by examining a liquid release amount per jo upon wiping a flooring for each jo. Thus, liquid release behavior can be estimated by measuring the liquid release amount (g) per jo and plotting the measured values.

As conditions for measuring the release behavior, a wiping weight (weight W) is 0.16 kN/m<sup>2</sup>, and a wiping velocity (velocity V) is 1 m/s. In the present invention, the release amount per jo is preferably 1 g or more, and an upper limit thereof is preferably 10 g or less.

{0043}

In the present invention, a maximum amount of the liquid charged in which the wiping liquid can be charged into the wet wiping sheet, namely, an initial amount of the liquid charged is preferably 1 g/sheet or more, more preferably 10 g/sheet, and further preferably 12 g/sheet or more. An upper limit of the initial amount of the liquid charged is practically 40 g/sheet or less, preferably 30 g/sheet, and further preferably 20 g/sheet or less.

{0044}

Thus, a targeted liquid release amount of 1 g/jo or more per wiping can be achieved, and also release can be continued in 6<sup>th</sup> jo or more.

{0045}

<Wiping liquid>

5           As the wiping liquid, the wiping liquid used in the wet wiping sheet is generally applied thereonto.

That is, the wiping liquid may be water alone or an aqueous solution containing a surfactant, but is preferably an aqueous solution containing a surfactant.

10       {0046}

As the surfactant, any of a nonionic surfactant, an amphoteric surfactant, a cationic surfactant or an anionic surfactant may be used. For example, the anionic surfactant such as alkylbenzenesulfonic acid, or the nonionic surfactant such as polyoxyethylene alkyl ether can be used.

15       {0047}

The wiping liquid may contain an additive. Specific examples of the additive include a polymer of acrylic acid, methacrylic acid or maleic acid, or a salt thereof, and a copolymer of maleic acid with any other vinyl-based monomer, or a salt thereof for the purpose of enhancing a rinsing effect. Moreover, specific  
20       examples thereof include a disinfectant, a flavoring agent, a perfuming agent, a deodorizing agent, abrasive particles, a pH adjuster, and a water-soluble organic solvent such as alcohol.

{0048}

As a content of the surfactant and the additive as described above, the  
25       surfactant and the additive are generally used in the range in which both are used in the wet wiping sheet.

{0049}

<<Method of producing wet wiping sheet>>

In the wet wiping sheet according to the present invention, at least two kinds of the fibers having different fiber diameters are entangled with each other. A production step of the present invention includes a hydroentangling step of blowing a water flow onto a stack of at least two layers of fiber aggregates having  
5 different fiber diameters of the fibers of the fiber aggregates forming the mutual layers to penetrate part of one fiber aggregate into the other fiber aggregate. In particular, part of one fiber aggregate is penetrated into the other fiber aggregate according to a hydroentangling method, in which fusion between the fibers as in an entangling method by hot air is not substantially caused.

10 {0050}

In the present invention, the water flow is preferably blown at least from a side of the layer of the fiber aggregate formed of the fibers having the small fiber diameter in the above-described stack. In this case, on the layer of the fiber aggregate formed of the fibers having the small fiber diameter, a nonwoven fabric  
15 or a net different from this layer may be arranged, and the water flow may be blown from a side of this nonwoven fabric or this net arranged, and then the nonwoven fabric or the net arranged may be peeled off. This embodiment is a preferable embodiment in the present invention. Moreover, an embodiment in which, after the nonwoven fabric or the net arranged is peeled off, the water flow  
20 is further blown from the layer of the fiber aggregate formed of the fibers having the small fiber diameter is a further preferable embodiment.

{0051}

The fiber diameter of the fibers having the small fiber diameter and the fiber diameter of the fibers having the large fiber diameter are the same as  
25 mentioned above, and the fiber length of the fibers having the small fiber diameter and the fiber length of the fibers having the large fiber diameter are also as described above.

{0052}

Basis weight of the fiber aggregate formed of the fibers having the small fiber diameter in the stack is preferably 1 g/m<sup>2</sup> or more and 100 g/m<sup>2</sup> or less, more preferably 5 g/m<sup>2</sup> or more and 50 g/m<sup>2</sup> or less, and further preferably 10 g/m<sup>2</sup> or more and 30 g/m<sup>2</sup> or less. Basis weight of the fiber aggregate formed of the fibers having the thick fiber diameter in the stack is preferably 10 g/m<sup>2</sup> or more and 50 g/m<sup>2</sup> or less, more preferably 15 g/m<sup>2</sup> or more and 30 g/m<sup>2</sup> or less, and further preferably 20 g/m<sup>2</sup> or more and 25 g/m<sup>2</sup> or less.

{0053}

Moreover, when, on the layer of the fiber aggregate formed of the fibers having the small fiber diameter, the nonwoven fabric different from this layer is arranged, basis weight of this nonwoven fabric is preferably 11 g/m<sup>2</sup> or more and 150 g/m<sup>2</sup> or less, more preferably 20 g/m<sup>2</sup> or more and 80 g/m<sup>2</sup> or less, and further preferably 30 g/m<sup>2</sup> or more and 75 g/m<sup>2</sup> or less. Here, in the present invention, this nonwoven fabric may be the fiber aggregate formed of the fibers having the large fiber diameter included below the layer of the fiber aggregate formed of the fibers having the small fiber diameter, and such an embodiment is preferable in the present invention.

{0054}

In the present invention, in the hydroentangling method (water needling) to be applied thereto, intertwining energy applied to the stack of the fiber aggregates can be controlled depending on conditions such as the number of water jet nozzles, a hydraulic pressure and a line speed.

{0055}

Here, on the layer of the fiber aggregate formed of the fibers having the small fiber diameter, the nonwoven fabric or the net different from this layer is arranged, and the resulting material is placed on a conveyor belt configured of a perforated mesh, and the water flow is blown from a side of the nonwoven fabric or the net arranged on the conveyor belt. Then, after the nonwoven fabric or the

net arranged is peeled off, the water flow is further blown from the side of the layer of the fiber aggregate formed of the fibers having the small fiber diameter. In this case, second conditions such as the number of water jet nozzles, the hydraulic pressure and the line speed may be changed from the first conditions.

5 {0056}

In the present invention, the stack formed of the fiber aggregates is placed on a perforated mesh outer shell, and the water flow is preferably sucked from a side opposite to a side on which the stack formed of the fiber aggregates is placed.

10 The perforated mesh outer shell may have a flat surface or a circular form, but a circular form is effective, which is preferable.

{0057}

In the present invention, the fibers may be fibrillated when the hydroentangling method is applied thereto, in which the fiber diameter of the fibers having the small fiber diameter obtained is preferably 0.1  $\mu\text{m}$  or more and 9  $\mu\text{m}$  or less.

15 {0058}

In the present invention, after the hydroentangling step, the wiping liquid is charged into the fiber aggregate on the second surface side in which a proportion of the fibers having the large fiber diameter present is larger. The content of the wiping liquid (charged amount into the fiber aggregate) is preferably 1 g /sheet or more, more preferably 10 g/sheet or more, and further preferably 12 g/sheet or more. An upper limit of the content of the wiping liquid is practically 40 g/sheet or less, preferably 30 g/sheet or less, and further preferably 20 g/sheet or less.

25 Specific examples of a method for incorporating the wiping liquid thereonto include a method of spraying the liquid in a roll-to-roll line, a method of passing the fiber aggregate through a liquid pool in a roll-to-roll manner, and a

method of spraying the liquid thereonto after cutting and stacking, and a method of spraying the liquid in a roll-to-roll line is preferable.

{0059}

<Method of producing fiber aggregate formed of fibers having small fiber

5 diameter among fiber aggregates>

As the fiber aggregate formed of the fibers having the small fiber diameter, a commercially available fiber aggregate formed of the fibers having the small fiber diameter may be used, but in the present invention, the fiber aggregate is preferably produced according to a melting type electrospinning method (melt  
10 electrospinning method).

{0060}

A device in which the melting type electrospinning method is performed is not particularly limited as long as the melting type electrospinning method can be achieved. The device has a heating and melting unit for heating and melting a  
15 thermoplastic resin, and an electrospinning unit for acting voltage onto the thermoplastic resin heated and melted to stretch this thermoplastic resin into a fiber form. The device further has a collection unit for collecting the stretched ultrafine fibers into a collector by electrical attraction.

{0061}

20 A heating means in the heating and melting unit may be the means which is applied in the melting type electrospinning method, and may be any means.

Moreover, the electrospinning unit also may be the unit which is applied in the melting type electrospinning method, and may be any unit. In addition, a heating zone preferably has a heating space zone in which a temperature can be  
25 controlled and the fibers to be stretched can be passed in 30 mm or more.

The collection unit may be configured of a collector for collecting the ultrafine fibers.

{0062}

Spun yarns obtained are collected into the collector, and stacked and spread in a sheet form (web) to produce a nonwoven fiber aggregate.

{0063}

The present invention neither has a weaving step nor requires a thermally shrinkable reticular net. Therefore, the number of steps is less, and the wet wiping sheet can be mass-produced in a simpler manner and inexpensively in comparison with such a producing method as performing a step of thermally shrinking high shrinkable fibers of the nonwoven fabric and a step of applying the hydroentangling method thereto.

10 {0064}

<<Application of wet wiping sheet>>

The wet wiping sheet of the present invention can be provided with diverse functions depending on the voids, a layer configuration, control of wettability and the like. Therefore, the wet wiping sheet of the present invention can be used for wiping of a building, such as floor surface and wall surface, fixtures such as a cabinet, a window glass, a mirror, a door and a doorknob, furniture such as a rug, carpet, table and dining table, and equipment such as a kitchen and a toilet. Moreover, the wet wiping sheet can be used for a cleaning wiper, and can also be used for bed bathing for a face, a body or the like, and also for a hygiene item, civil engineering, packaging or the like.

{0065}

Here, FIGs. 5 to 7 show produced typical wet wiping sheets of the present invention as described above. Specifically, the fiber aggregate formed of the fibers having the small fiber diameter was formed according to the melting type electrospinning method. The fibers were made of polypropylene, and a spinning diameter obtained, namely, the fiber diameter was 0.6 to 3  $\mu\text{m}$ . As the aggregate of the fibers having the large fiber diameter, a polyethylene terephthalate, rayon and acrylic-blended nonwoven fabric having a fiber diameter

of 10 to 18  $\mu\text{m}$  was used.

{0066}

Basis weight of the nonwoven fabric formed of the aggregate of the fibers having the large fiber diameter was  $65 \text{ g/m}^2$ , and basis weight of the produced  
 5 fiber aggregate formed of the fibers having the small fiber diameter was  $55 \text{ g/m}^2$ . A high-pressure jet water flow was blown again between two nonwoven fabrics of the aggregates formed of the fibers having the large fiber diameter and the fibers having the small fiber diameter from a side of the fiber aggregate formed of the fibers having the small fiber diameter to penetrate part of one fiber aggregate into  
 10 the other fiber aggregate. Basis weight of the fibers of the sheet as a whole obtained was  $120 \text{ g/m}^2$ .

{0067}

FIG. 5 shows a photograph obtained by observing a sheet cross section of this sheet by using the scanning electron microscope.

15 An upper side of the figure serves as the first surface (wiping surface).

{0068}

Then, the wiping liquid was injected therein from a side of the nonwoven fabric of the aggregate formed of the fibers having the large fiber diameter, and as a result, a content of  $7.8 \text{ g/sheet}$  was able to be achieved. FIG.  
 20 6 shows a graph showing a relationship between the liquid release amount (g) per jo and the wiping area (jo) by plotting the measured values by using the thus produced wet wiping sheet.

{0069}

As shown in FIG. 6, the liquid release amount per jo was 1 g or more up  
 25 to 7<sup>th</sup> jo. Moreover, a release rate at 14<sup>th</sup> jo was 81%. In addition, a rate of impregnation was determined according to an expression:  $\{(\text{mass of impregnated liquid}) / (\text{mass of fibers})\} \times 100$ , and the rate of impregnation was 380%.

Frictional resistance was 1.6 N, which was reduced than the frictional

resistance of a sheet formed of fibers having a fiber diameter of 0.3 to 3  $\mu\text{m}$  on the whole surface, and was approximately equivalent to the frictional resistance of a microfiber sheet formed of fibers having a fiber diameter of 10 to 18  $\mu\text{m}$  on the whole surface.

5 {0070}

Here, the frictional resistance was determined by mounting a wiper head onto a push-pull gauge, scanning the sheet to be in parallel with a wiping flat surface in an angle of the push-pull gauge, measuring a maximum value of stress, and plotting the measured values.

10 {0071}

FIG. 7 shows a photograph of the first surface after wiping the surface by using the above-described wet wiping sheet, in which it is observed that uneven portions are not uniform and are stuffed with the dirt. FIG. 7 suggests that the dirt which has been unable to be completely removed so far is removed therefrom from observation of the photograph as described above.

{0072}

Thus, the present invention is able to provide the wet wiping sheet capable of removing dirt by lightly wiping the surface, without being changed or with only a few changes, even if area is large. Furthermore, the present invention is able to provide the method of producing the wet wiping sheet, according to which the wet wiping sheet can be mass-produced in a simple manner.

{0073}

With regard to the above-mentioned embodiments, the present invention further discloses, including the above-described wet wiping sheet, the following wet wiping sheet and method of producing the same.

{0074}

(1) A wet wiping sheet, containing a fiber aggregate of at least two kinds of fibers having different fiber diameters,

wherein the wet wiping sheet has a first surface and a second surface on a side opposite to the first surface;

wherein the at least two kinds of fibers having different fiber diameters are entangled with each other,

5            wherein proportion of fibers having a small fiber diameter present in the fiber aggregate is larger on the first surface side than on the second surface side, proportion of fibers having a large fiber diameter present in the fiber aggregate is larger on the second surface side than on the first surface side, and capillary pressure on the first surface side is higher than the capillary pressure on the  
10    second surface side, and

          wherein a wiping liquid is charged into at least the fiber aggregate on the second surface side.

(2)        The wet wiping sheet described in the above item (1), wherein the fibers having different fiber diameters are entangled with each other without being  
15    thermally fused to each other.

(3)        The wet wiping sheet described in the above item (1) or (2), wherein the aggregate of the fibers having a small fiber diameter, and the fibers having a large fiber diameter are present on the first surface of the wet wiping sheet.

(4)        The wet wiping sheet described in any one of the above items (1) to (3),  
20    wherein the area percentage of the fibers having the small fiber diameter on the first surface is preferably 40% or more and 99% or less, more preferably 45% or more and 95% or less, and further preferably 50% or more and 90% or less.

(5)        The wet wiping sheet described in any one of the above items (1) to (4), wherein, among the fibers having different fiber diameters, the fiber diameter of  
25    the fibers having a small fiber diameter is 0.1  $\mu\text{m}$  or more and 9  $\mu\text{m}$  or less, and preferably 0.5  $\mu\text{m}$  or more and 5  $\mu\text{m}$  or less.

(6)        The wet wiping sheet described in any one of the above items (1) to (5), wherein, among the fibers having different fiber diameters, the fiber diameter of

the fibers having a large fiber diameter is 10  $\mu\text{m}$  or more and 30  $\mu\text{m}$  or less and preferably 15  $\mu\text{m}$  or more and 25  $\mu\text{m}$  or less.

(7) The wet wiping sheet described in any one of the above items (1) to (6), wherein the fibers having different fiber diameters are fibers having the same component.

(8) The wet wiping sheet described in any one of the above items (1) to (6), wherein the fibers having different fiber diameters are fibers having the different component.

(9) The wet wiping sheet described in any one of the above items (1) to (8), which is formed of at least two layers of a liquid holding layer in which the wiping liquid is charged,

wherein a liquid release layer, and the liquid release layer includes the first surface.

(10) The wet wiping sheet described in any one of the above items (1) to (9), wherein the area percentage of the fibers having a small fiber diameter is adjusted to 1% or more and 100% or less in 50% or more and 100% or less of the thickness of the wet wiping sheet from the second surface, and the liquid holding layer in which the large amount of the wiping liquid is charged is formed on the second surface side.

(11) The wet wiping sheet described in any one of the above items (1) to (10), wherein a release amount of the wiping liquid when the wiping liquid is released from the first surface to target surface by wiping the target surface once is 0.5 g/jo or more, preferably 0.7 g/jo or more, and more preferably 1.0 g/jo or more (the term "jo" means a unit having an area of 1.6552  $\text{m}^2$ ).

(12) The wet wiping sheet described in any one of the above items (1) to (11), wherein a release amount of the wiping liquid when the wiping liquid is released from the first surface to target surface by wiping the target surface once is 8 g/jo or less, preferably 7 g/jo or less, and more preferably 6 g/jo or less (the term "jo"

means a unit having an area of  $1.6552 \text{ m}^2$ ).

(13) The wet wiping sheet described in any one of the above items (1) to (12), wherein an amount of charging the wiping liquid into a fiber aggregate on a side opposite to the first surface is larger than on the first surface.

5 {0075}

(14) A method of producing the wet wiping sheet described in any one of the above items (1) to (13), containing a hydroentangling step of blowing a water flow onto a stack formed of at least two layers of fiber aggregates having different fiber diameters of fibers of the fiber aggregates forming mutual layers to penetrate part  
10 of one fiber aggregate into the other fiber aggregate,

wherein the water flow is blown at least from a side of a layer of the fiber aggregate formed of the fibers having the small fiber diameter in the stack.

(15) The method of producing the wet wiping sheet described in the above item (14), wherein, in the hydroentangling step, a nonwoven fabric or a net

15 different from the layer is arranged on a layer of the fiber aggregate formed of the fibers having the small fiber diameter; the water flow is blown from a side of the nonwoven fabric or the net arranged; and after the water flow is blown, the nonwoven fabric or the net arranged is peeled off.

(16) The method of producing the wet wiping sheet described in the above  
20 item (15), wherein, after the nonwoven fabric or the net is peeled off, the water flow is further blown from the side of the layer of the fiber aggregate formed of the fibers having the small fiber diameter.

(17) The method of producing the wet wiping sheet described in any one of the above items (14) to (16), wherein the fiber aggregate formed of the fibers  
25 having the small fiber diameter among the fiber aggregates is produced according to a melting type electrospinning method.

(18) The method of producing the wet wiping sheet described in any one of the above items (14) to (17), wherein the stack formed of the fiber aggregates is

placed on a perforated mesh outer shell, and the water flow is sucked from a side opposite to a side on which the stack formed of the fiber aggregates is placed.

(19) The method of producing the wet wiping sheet described in any one of the above items (14) to (18), wherein the fibers are fibrillated by the

5 hydroentangling method.

{0076}

Having described our invention as related to this embodiments, it is our intention that the invention not be limited by any of the details of the description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

10

{0077}

This application claims priority on Patent Application No. 2016-236112 filed in Japan on December 5, 2016, and Patent Application No. 2017-154681 filed in Japan on August 9, 2017, each of which is entirely herein incorporated by reference.

15

## CLAIMS

{Claim 1}

- 5 A wet wiping sheet, comprising a fiber aggregate of at least two kinds of fibers having different fiber diameters,
- wherein the wet wiping sheet has a first surface and a second surface on a side opposite to the first surface;
- wherein at least two kinds of fibers having different fiber diameters are entangled with each other,
- 10 wherein proportion of fibers having a small fiber diameter present in the fiber aggregate is larger on the first surface side than on the second surface side, proportion of fibers having a large fiber diameter present in the fiber aggregate is larger on the second surface side than on the first surface side, and capillary pressure on the first surface side is higher than the capillary pressure on the
- 15 second surface side, and
- wherein a wiping liquid is charged into at least the fiber aggregate on the second surface side.

{Claim 2}

- 20 The wet wiping sheet according to Claim 1, wherein the fibers having different fiber diameters are entangled with each other without being thermally fused to each other.

{Claim 3}

- 25 The wet wiping sheet according to Claim 1 or 2, wherein the aggregate of the fibers having a small fiber diameter, and the fibers having a large fiber diameter are present on the first surface of the wet wiping sheet.

{Claim 4}

The wet wiping sheet according to any one of Claims 1 to 3, wherein the area percentage of the fibers having the small fiber diameter on the first surface is 40% or more and 99% or less.

5

{Claim 5}

The wet wiping sheet according to any one of Claims 1 to 4, wherein, among the fibers having different fiber diameters, the fiber diameter of the fibers having a small fiber diameter is 0.1  $\mu\text{m}$  or more and 9  $\mu\text{m}$  or less.

10

{Claim 6}

The wet wiping sheet according to any one of Claims 1 to 5, wherein, among the fibers having different fiber diameters, the fiber diameter of the fibers having a large fiber diameter is 10  $\mu\text{m}$  or more and 30  $\mu\text{m}$  or less.

15

{Claim 7}

The wet wiping sheet according to any one of Claims 1 to 6, wherein the fibers having different fiber diameters are fibers having the same component.

20

{Claim 8}

The wet wiping sheet according to any one of Claims 1 to 6, wherein the fibers having different fiber diameters are fibers having the different component.

{Claim 9}

25

The wet wiping sheet according to any one of Claims 1 to 8, which is formed of at least two layers of a liquid holding layer in which the wiping liquid is charged, and a liquid release layer,

wherein the liquid release layer includes the first surface.

{Claim 10}

The wet wiping sheet according to any one of Claims 1 to 9, wherein the area percentage of the fibers having a small fiber diameter is adjusted to 1% or more and 100% or less in 50% or more and 100% or less of the thickness of the wet wiping sheet from the second surface, and the liquid holding layer in which the large amount of the wiping liquid is charged is formed on the second surface side.

10 {Claim 11}

The wet wiping sheet according to any one of Claims 1 to 10, wherein a release amount of the wiping liquid released from the first surface to target surface by wiping the target surface once is 0.5 g/jo or more (the term "jo" means a unit having an area of 1.6552 m<sup>2</sup>).

15

{Claim 12}

The wet wiping sheet according to any one of Claims 1 to 11, wherein a release amount of the wiping liquid released from the first surface to target surface by wiping the target surface once is 8 g/jo or less (the term "jo" means a unit having an area of 1.6552 m<sup>2</sup>).

20

{Claim 13}

The wet wiping sheet according to any one of Claims 1 to 12, wherein an amount of charging the wiping liquid into a fiber aggregate on a side opposite to the first surface is larger than on the first surface.

25

{Claim 14}

A method of producing the wet wiping sheet according to any one of

Claims 1 to 13, comprising a hydroentangling step of blowing a water flow onto a stack formed of at least two layers of fiber aggregates having different fiber diameters of fibers of the fiber aggregates forming mutual layers to penetrate part of one fiber aggregate into the other fiber aggregate,

- 5                wherein the water flow is blown at least from a side of a layer of the fiber aggregate formed of the fibers having the small fiber diameter in the stack.

{Claim 15}

- The method of producing the wet wiping sheet according to Claim 14,  
10        wherein, in the hydroentangling step, a nonwoven fabric or a net different from the layer is arranged on a layer of the fiber aggregate formed of the fibers having the small fiber diameter; and the water flow is blown from a side of the nonwoven fabric or the net arranged; and after the water flow is blown, the nonwoven fabric or the net arranged is peeled off.

15

{Claim 16}

- The method of producing the wet wiping sheet according to Claim 15,  
              wherein, after the nonwoven fabric or the net is peeled off, the water flow is further blown from the side of the layer of the fiber aggregate formed of the fibers  
20        having the small fiber diameter.

{Claim 17}

- The method of producing the wet wiping sheet according to any one of Claims 14 to 16, wherein the fiber aggregate formed of the fibers having the small  
25        fiber diameter among the fiber aggregates is produced according to a melting type electrospinning method.

{Claim 18}

The method of producing the wet wiping sheet according to any one of Claims 14 to 17, wherein the stack formed of the fiber aggregates is placed on a perforated mesh outer shell, and the water flow is sucked from a side opposite to a side on which the stack formed of the fiber aggregates is placed.

5

{Claim 19}

The method of producing the wet wiping sheet according to any one of Claims 14 to 18, wherein the fibers are fibrillated by the hydroentangling method.