

CLEANING SHEET

BACKGROUND

5 Dust cloths for removing dust from a surface to be cleaned, such as a table, are generally known. Such known dust cloths may be made of woven or nonwoven fabrics and are often sprayed or coated with a wet, oily substance for retaining the dust. Such cloths tend to leave an oily film on the surface after use and do not usually contain any substantial amount of surfactant.

10 Other known dust cloths include nonwoven entangled fibers having spaces between the entangled fibers for retaining the dust. The entangled fibers may be supported by a network grid or scrim structure, which can provide additional strength to such cloths. Cloths of this type can become saturated with the dust during use (i.e., dust buildup) and/or may not be completely effective at picking up denser particles, large particles or
15 other debris. Such cloths are also typically designed to be used primarily as a dry dust cloth.

 Cloths used as wet cleaning pads are generally known. The cloths may be formed using woven or nonwoven fibers. Such cloths may be pre-impregnated with water and soap, or may be sold dry, e.g., as a soap pad. These cloths are generally characterized by a
20 relatively loading of surfactant, which is released when the water contacts the pad. The primary use for such cloths is in wet cleaning, such as dish scrubbing. Other wipes which have been pre-impregnated with a cleaning solution have been reported for use in applications such as car washing. Soap pads and wet wipes such as these are not usually designed to be utilized in dry cleaning.

25 Accordingly, it would be advantageous to provide cleaning sheets that can both pick-up and retain debris in dry cleaning and release surfactant to enhance its effectiveness when used in wet cleaning. Such a cleaning sheet would preferably be capable of retaining larger particulates and other debris such as hair and lint, while at the same time being very effective for picking up and retaining fine dust particles. Such a cleaning sheet
30 would also be capable of releasing surfactant deposited on the fibers with suitable properties to enhance its use in wet cleaning.

SUMMARY OF THE INVENTION

The present invention relates generally to cleaning sheets for use in cleaning surfaces, such as in the home or work environment. More particularly, the invention relates to a dry cleaning sheet with wet cleaning capabilities, used in dry form for
5 collecting and retaining dust, larger particles and/or other debris and for cleaning surfaces while wet. The cleaning sheet includes a surface covered with a fabric material capable of picking up and retaining particulate matter and other debris, such as hair and lint. The fabric material may optionally be treated with and/or incorporate therein a dust adhesion agent to enhance its effectiveness. A relatively low level of surfactant is typically
10 deposited on at least some of the fibers of the fabric to enhance the ability of the sheet to be utilized in wet cleaning. The inclusion of the surfactant can enhance the capability of the cleaning sheet to use, after being wet with water, as an aid in removing dirt, stains and/or deposits from a surface.

The cleaning sheet includes a fabric layer which has a relatively low level of
15 surfactant deposited on at least a portion of the fibers. The fabric material is selected to be capable in dry form of picking up and retaining particulate matter and other debris, such as hair and lint. The sheets can also be used as wet wipes by impregnating the sheet with water or other cleaning solutions to facilitate the removal of troublesome stains or deposits. The cleaning sheets generally have a breaking strength of at least 500g/30 mm.
20 Cleaning sheets which are intended for use mounted on an implement, such as a mop head, generally have an elongation at a load of 500g/30 mm of no more than about 25%.

The surfactant commonly is a paste or solid at room temperature and has a relatively low water solubility, e.g., a water solubility of no more than about 20 wt.% at 25°C. The latter property is often satisfied by surfactants that have an
25 hydrophilic/lipophilic balance ("HLB") of about 10 to 18. Examples of surfactants which have such properties include a wide variety of commercially available nonionic and anionic surfactants.

Surfactant can be deposited on the fibers of the sheet in a continuous fashion or in random or repeating patterns. The surfactant is generally chosen and deposited in such an
30 amount that residue does not normally rub off during use of the cleaning sheet in dry cleaning methods. The surfactant may be applied to the fabric layer by rolling, spraying, or other methods. The surfactant is preferably applied to the fabric layer in a manner that does not impart too much stiffness and/or rigidity to the sheet. Depending on the type of

surfactant(s) and manner of application, the surfactant can be deposited to various depths on and/or around the fibers. The result of surfactant deposit is a flexible cleaning cloth that is capable of releasing a portion of the surfactant when the sheet is wet.

In one embodiment, the cleaning sheet includes a nonwoven fiber aggregate layer
5 formed from a loosely entangled fibrous web. Such a fibrous web typically has a basis weight of 50 to 150 g/m² and a CD initial modulus ("entanglement coefficient") of no more than 800 m. Surfactant is commonly deposited on no more than about 20% of the fibers which make up the web and, more typically, is deposited on no more than 10% of the fibers. Preferably, the nonwoven aggregate is formed from microfibers which have a
10 denier of no more than 3. To enhance the ability of the fibrous web to pick up and retain particulates and oils, it may be advantageous to form the nonwoven aggregate from a mixture of moderately fine and very fine microfibers, e.g., a mixture of microfibers having a denier of 1-2 and microfibers having a denier of 0.5 to 0.9.

Woven fabrics formed from microfibers, such as a sheet of Scotchbrite[™] material
15 (available from 3M Corporation, St. Paul, MN), can also be treated with surfactant and used as the fabric layer in the present cleaning sheets. Such woven webs are typically formed from the same types of microfibers as the nonwoven webs described herein. The woven fabrics are generally formed from microfibers having a denier of no more than about 3.

20 The present cleaning sheets can be produced by imprinting a pattern of surfactant, e.g., either as a melt or as a mixture with a relatively volatile solvent. If a solvent containing mixture is employed, the treated sheet is typically subjected to a flow of air (either with or without exposure to a source of heat) to drive off residual solvent.

As used herein, the term "entanglement coefficient" refers to the initial gradient of
25 the stress-strain curve measured with respect to the direction perpendicular to the fiber orientation in the fiber aggregate (cross machine direction). The entanglement coefficient is also referred to herein as the "CD initial modulus." Suitable nonwoven fiber aggregates for use in forming the present cleaning sheets commonly have an entanglement coefficient of 20 to 800 m (as measured after any reinforcing filaments or network has been removed
30 from the nonwoven fibrous web) and, more typically, no more than about 300 m.

The entanglement coefficient (also referred to herein as "CD initial modulus") as used herein is a measure representing the degree of entanglement of fibers in the fiber aggregate. The entanglement coefficient is expressed by the initial gradient of the stress-

strain curve measured with respect to the direction perpendicular to the fiber orientation in the nonwoven fiber aggregate, i.e., in the cross machine direction ("cross direction" or "CD"). A smaller value of the entanglement coefficient represents a smaller degree of entanglement of the fibers. The term "stress" as used herein means a value which is obtained by dividing the tensile load value by the chucking width (i.e. the width of the test strip during the measurement of the tensile strength) and the basis weight of the nonwoven fiber aggregate. The term "strain" as used herein is a measure of the elongation of the cleaning sheet material.

The term "breaking strength" as used herein refers to the value of a load (i.e. the first peak value during the measurement of the tensile strength) at which the cleaning sheet begins to break when a tensile load is applied to the cleaning sheet.

As used herein, the term "elongation" refers to the relative increase in length (in percent) of a 30 mm strip of cleaning sheet material when a tensile load of 500 g is applied to the strip. The strip is elongated at a rate of 30 mm/min in the direction perpendicular to the fiber orientation (i.e. in the cross machine direction).

As used herein the term "nonwoven web" means a web having a structure of individual fibers or threads which are interlaid, but not in a regular or identifiable manner as in a knitted fabric. The term "nonwoven fabric" includes nonwoven webs as well as individual filaments and strands, yarns or tows as well as foams and films that have been fibrillated, apertured, or otherwise treated to impart fabric-like properties. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, and bonded carded web processes. Throughout this application, the terms "nonwoven fiber aggregate", "fibrous web", and "nonwoven aggregate" are used interchangeably with the term "nonwoven web".

The basis weight of nonwoven fabrics is usually expressed in ounces of material per square yard ("osy") or grams per square meter ("gsm") and the fiber diameters useful are usually expressed in microns. Basis weights can be converted from osy to gsm simply by multiplying the value in osy by 33.91.

As used herein the term "microfibers" means small diameter fibers having an average diameter not greater than about 75 microns, for example, having an average diameter of from about 0.5 microns to about 50 microns, or more particularly, microfibers may have an average diameter of from about 2 microns to about 40 microns. Another frequently used expression of fiber diameter is denier, which is defined as grams per 9000

meters of a fiber and may be calculated as fiber diameter in microns squared, multiplied by the density in grams/cc, multiplied by 0.00707. A lower denier indicates a finer fiber and a higher denier indicates a thicker or heavier fiber. For example, the diameter of a polypropylene fiber given as 15 microns may be converted to denier by squaring, multiplying the result by .89 g/cc and multiplying by .00707. Thus, a 15 micron polypropylene fiber has a denier of about 1.42 ($15^2 \times 0.89 \times .00707 = 1.415$). Outside the United States the unit of measurement is more commonly the “tex”, which is defined as the grams per kilometer of fiber. Tex may be calculated as denier/9.

As used herein, the term “average cross-sectional dimension” refers to the average dimension of a region in an outer fabric surface of the present cleaning sheet. The “average cross-sectional dimension” (“ACSD”) is equal to one half of the sum of the length of the longest cross sectional axis (“ L^l ”) of the cavity plus the cross sectional axis perpendicular to the longest cross sectional axis (“ L^s ”), i.e.,

$$ACSD = (L^l + L^s)/2.$$

The term “cross-sectional area” is used herein to refer to the area of a region in the outer plane of the fabric surface (i.e., in the cleaning surface).

It is important to note that the terms “surface” and “surface to be cleaned” as used in this disclosure are broad terms and are not intended as terms of limitation. The term surface includes substantially hard or rigid surfaces (e.g., articles of furniture, tables, shelving, floors, ceilings, hard furnishings, household appliances, and the like), as well as relatively softer or semi-rigid surfaces (e.g., rugs, carpets, soft furnishings, linens, clothing, and the like).

It is also important to note that the term “debris” is a broad term and is not intended as a term of limitation. In addition to dust and other fine particulate matter, the term debris includes relatively large-sized particulate material, e.g., having an average diameter greater than about 1 mm, such as large-sized dirt, soil, lint, and waste pieces of fibers and hair, which may not be collected with conventional dust rags, as well as dust and other fine dirt particles.

As employed herein, the term “melting point” is used to refer to the temperature at which a material transforms from a solid to a liquid, i.e., when a phase change involving a heat of fusion occurs. The term “pour point” as used herein refers to the temperature at

which the material stops flowing (as measured by ASTM method D 97). Thus pour point is a property which may involve a phase change but generally is based on a change in the viscosity properties of the material.

Throughout this application, the text refers to various embodiments of the cleaning sheet. The various embodiments described are meant to provide illustrative examples and should not necessarily be construed as descriptions of alternative species. Rather it should be noted that the descriptions of various embodiments provided herein may be of overlapping scope. The embodiments discussed herein are merely illustrative and are not meant to limit the scope of the present invention.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows a plan view of a portion of a nonwoven fiber layer with surfactant deposited on the fibers which can be used to form a cleaning sheet.

Figure 2 shows a cross-sectional view of a portion of a nonwoven fiber layer depicted in Figure 1.

Figure 3 shows a plan view of a portion of a woven fiber layer with surfactant deposited on the fibers which can be used to form a cleaning sheet.

Figure 4 shows a plan view of a lattice-like network sheet which can be used to reinforce a nonwoven fiber aggregate layer employed to produce one example of the present cleaning sheet.

Figure 5 shows a cross-sectional view of a lattice-supported nonwoven fiber aggregate layer which can be employed to produce a cleaning sheet.

Figure 6 is a graph showing a stress-strain curve for a typical nonwoven fiber aggregate layer which can be used to form a cleaning sheet.

DETAILED DESCRIPTION

The present cleaning sheets are very effective when used as a dry dust cloth to collect and retain oils, particulates, lint hair and other debris from a surface. In addition, the sheets are capable of being used in wet cleaning applications. For example, the sheets can be saturated with water to aid in removing dirt, stains and/or deposits from a surface. The cleaning sheet includes a fabric layer which has a relatively low level of surfactant deposited on at least a portion of the fibers. The fabric material is selected such that it is capable in dry form of picking up and retaining oils, particulate matter and/or other debris, such as hair and lint. The sheets can also be used as wet wipes by impregnating the sheet

with water or other cleaning solutions where necessary to facilitate the removal of troublesome stains or deposits.

The cleaning sheets include a relatively low level of surfactant, typically of a type classed as a hard surface cleaner. The surfactant may be distributed uniformly throughout a nonwoven fabric layer of the sheet. More commonly, the surfactant is distributed in discrete regions of the nonwoven layer interspersed between regions which are untreated with the same level of surfactant. The discontinuous surfactant-containing regions may be discrete regions which can have a variety of shapes. For example, the surfactant-containing regions can be round ("dots"), polygon shaped or have an irregular ("amorphous") shape. Figure 1 depicts a section of a cleaning sheet formed from a nonwoven fiber aggregate 1 which has a plurality of round surfactant-containing regions 2. Alternatively, the discontinuous surfactant-containing regions can have linear shapes, e.g., curved lines such as shown in Figure 3. The surfactant may only be deposited on the fibers on the exterior surface of the sheet. More commonly, however, the surfactant is applied in such a manner that the surfactant is deposited on interior fibers as well as fibers near the exterior surface of the web. Figure 2 depicts a fibrous web which includes surfactant containing regions 3 which extend from an exterior surface into the interior of the web. Fibrous webs of this type can be produced by applying the surfactant as a melt or solvent containing mixture that has a sufficiently low viscosity to permit the surfactant to be transported into the web. The surfactant-containing regions may be arranged in a regular, repeating pattern or may be randomly distributed.

The cross sectional area of all the regions which include surfactant is generally at least about 2-3% of the total surface area of the exterior surface of the fabric layer. The total cross sectional area of these regions is commonly no more than about 25% of the total surface area. This allows the inclusion of sufficient surfactant to facilitate the removal of tough deposits and the like without substantially altering the overall properties of the sheet when used as a dry dust cloth. Examples of particularly suitable cleaning sheets include those where the cross sectional area of all the surfactant-containing regions relative to the total surface area is about 5% to 10%, although in some instances the surfactant-containing regions may make up a larger percentage of the total surface area of a cleaning sheet, e.g., up to about 40% of the total area. As mentioned elsewhere herein, in other embodiments the low level of surfactant may be uniformly dispersed over the entire surface of the fabric layer.

Surfactant(s)

The surfactant may be printed or sprayed onto the surface to be coated. Depending on the design of the cleaning sheet, the surfactant may be applied as a continuous layer, e.g., onto one side of a fibrous web or a flexible backing layer used to form the sheet, or applied in a discontinuous manner. For example, the surfactant may be rolled or sprayed (either as a solution or a melt) onto specific regions on the outer fabric surface of the sheet. In another embodiment, cleaning sheets may be formed by spreading or spraying discontinuous patches of a surfactant onto a flexible backing layer and bringing a fibrous web into contact with the backing layer such that at least a portion of the surfactant is deposited onto fibers in the web.

Specific examples of suitable types of surfactants include anionic surfactants and nonionic surfactants. The surfactant is chosen so that it is a paste or solid at ordinary room temperatures (i.e., at temperatures close to 25°C). More commonly the surfactant has a melting point of at least about 35°C and preferably at least about 40°C. The surfactant also generally has a relatively low water solubility. This can accomplish at least two objectives. When the cleaning sheet is employed in wet state, the amount of surfactant which dissolves in the water impregnated into the sheet will be low, resulting in a low dosage of surfactant onto the surface being cleaned. This avoids the build up of a surfactant residue on the surface. In addition, if the surfactant is relatively insoluble, not all of the surfactant in the sheet will generally be dissolved during a single use. This permits the sheet to be used more than once and preferably multiple times before disposal. The surfactant may also be characterized in terms of its hydrophilic/lipophilic balance ("HLB"). This is a parameter commonly used in the surfactant art to characterize the relative amount of hydrophilic and lipophilic nature in a given surfactant. Surfactants with low HLBs are more lipophilic. Surfactants with higher HLBs are more hydrophilic and tend to be more water soluble. To enhance the wet cleaning capabilities of the present sheets, it is generally advantageous to use surfactants which have an HLB of 10 to 18 and, preferably, 13 to 16.

Examples of suitable nonionic surfactants which can be used to enhance the wet cleaning utility of the present sheets include ethoxylated alkanols, ethoxylated alkenols, polyoxypropylene-polyoxyethylene block copolymers, polyethyleneglycol monoesters, alkylphenoxy-polyethyleneoxides, fatty acid glycol monoesters, paraffinic ethoxylate carboxylates, alkyldimethylamine oxides, and fatty acid hydroxyalkyl amides. Examples

of suitable polyoxypropylene-polyoxyethylene block copolymers copolymers include copolymers having an HLB of 12 to 18. Examples of suitable polyethyleneglycol monoesters include fatty acid monoesters and, in particular, such monoesters where the fatty acid has 12 to 18 carbon atoms. ethoxylated fatty alcohol having an alkyl group with
5 16 to 18 carbon atoms.

As noted above, the surfactant can also include anionic surfactant. Examples of suitable anionic surfactants which may be utilized as part of the present cleaning sheets include fatty acid salts, alkanesulfonate salts, alkylbenzenesulfonate salts, alkanol sulfate salts, and the like. Examples of suitable fatty acid salts include calcium and/or magnesium
10 salts of fatty acids. Such salts typically include salts of fatty acids having at least 11 to 17 carbon atoms in the alkyl side chain.

Because the present cleaning sheets are often used in wet cleaning applications where a soiled surface is wiped or scrubbed with the wetted sheet without a subsequent rinse, it is generally preferable to employ surfactant which have a relatively low foaming
15 character. For example, it may be particularly suitable to utilize surfactants which have a foam height in the Ross Miles foam test at 50°C (referred to herein as "Ross Miles foam height") of no more than about 100 mm and, preferably, no more than about 75 mm.

Typically, the cleaning sheet has an overall thickness of at least about 1 mm and, suitable cleaning sheets often have thicknesses of about 1.5 mm to 3 mm or even thicker.
20 Embodiments of the present cleaning sheets commonly may not include a flexible backing layer. In this instance, the fabric layer is generally somewhat thicker. For example, such sheets may be formed from a slightly thicker fabric layer (e.g., about 3 mm to 5 mm). The flexible backing layer which is present in other embodiments of the cleaning sheet typically serves to provide strength and dimensional stability to the sheet. These functions
25 may also be provided by a suitably designed fabric layer. Such sheets may be suitably thick enough to include a plurality of supporting filaments and/or a supporting network sheet within the layer.

According to a particularly suitable embodiment, the cleaning sheet includes an nonwoven fabric layer formed from microfibers. The nonwoven fabric layer is typically a
30 loose aggregate of the microfibers. The denier of the fibers in the fiber aggregate, the length, the cross-sectional shape and the strength of the fibers used in the nonwoven fiber aggregate are typically also determined with an eye toward processability and cost, among other factors. The microfibers commonly have a denier of about 0.1 to 5 and, more

typically, about 0.5 to 2. One example of a suitable nonwoven fabric for use as the outer surface layer of a cleaning sheet is nonwoven fiber aggregate layer formed from a mixture of relatively thicker microfibers having a denier of 1 to 2 and finer fibers having a denier of no more than about 0.9 and generally at least about 0.2 (preferably about 0.5 to 0.9).

5 Such nonwoven aggregates for use in producing the present cleaning sheets suitably have such thicker and finer fibers present in a weight ratio of about 50:50 to about 20:80.

Figure 2 shows a cross-sectional view of one embodiment of the present cleaning sheet. The nonwoven aggregate layer of the cleaning sheet is shown made of an entangled network of nonwoven fibers 1 having a plurality of surfactant-containing regions 3
10 therein. Pores which can also trap debris are formed by the spaces between the entangled fibers in the nonwoven layer (i.e., debris can be retained between the fibers that form the nonwoven aggregate layer). Typically, the surfactant is deposited on the fibers in the regions 4 such that the pores between the fibers are substantially similar to those of the corresponding untreated fabric.

15 In another embodiment, a web or lattice (shown as a scrim) may be embedded in and support the fibers of the nonwoven layer. The scrim is commonly integrally embedded within the fibers of the nonwoven aggregate layer to form a unitary structure for the layer. The scrim typically includes a net having horizontal members attached to vertical members arranged in a "network" configuration. Spaces (shown as holes) are
20 formed between vertical members and horizontal members to give scrim a mesh or lattice-like structure. According to various embodiments, the horizontal and vertical members of the scrim may be connected together in a variety of ways such as woven, spot welded, cinched, tied, etc. One example of a such a lattice which may be used to provide support for the nonwoven layer during processing and use is shown in Figure 4.

25 To attach the fibers to a scrim, thereby forming nonwoven fiber aggregate layer as a unitary structure, the fibers may be overlaid on each side of the scrim. A low pressure water jet can then be applied to entangle the fibers of the nonwoven fiber aggregate to each other and to the scrim (i.e., hydroentanglement) to form a relatively loose entanglement of nonwoven fibers. Hydroentanglement of the fibers may be further
30 increased during removal (e.g., drying) of the water from the water jet. The fibers may also be attached to the network sheet by other methods known to those of skill in the art (e.g., air laid, adhesive, woven). The fibers are typically entangled onto the web to form a unitary body, which can assist in preventing "shedding" of the fibers from the web during

cleaning. Figure 5 shows one example of a scrim-supported nonwoven layer 11 which can be utilized as the fabric layer in forming the present cleaning sheets. The cross-sectional view of the scrim-supported nonwoven fiber aggregate 11 shows the filaments 12 embedded within an hydroentangled nonwoven fiber web 13.

5 As fabric layer used to form the present cleaning sheets, a nonwoven aggregate layer having fibers with a large degree freedom and sufficient strength is advantageous for effectively collecting and retaining dust and larger particulates within the cleaning sheet. In general, a nonwoven fabric formed by the entanglement of fibers involves a higher degree of freedom of the constituent fibers than in a nonwoven fabric formed only by
10 fusion or adhesion of fibers. The nonwoven fabric formed by the entanglement of fibers can exhibit better dust collecting performance through the entanglement between dust and the fibers of the nonwoven fabric. The degree of the entanglement of fibers can have a large effect on the retention of dust. That is, if the entanglement becomes too strong, the freedom of fibers to move will be lower and the retention of dust is generally decreased.
15 In contrast, if the entanglement of the fibers is very weak, the strength of the nonwoven fabric can be markedly lower, and the processability of the nonwoven fabric may be problematic due to its lack of strength. Also, shedding of fibers from the nonwoven fabric is more likely to occur from a nonwoven aggregate with a very low degree of entanglement.

20 A suitable nonwoven aggregate for use in producing the present cleaning sheets can be formed by hydroentangling a fiber web (with or without embedded supporting filaments or a network sheet) under relatively low pressure. For example, the fibers in a carded polyester nonwoven web can be sufficiently entangled with a network sheet by processing the nonwoven fiber webs with water jetted at high speed under $25\text{-}50\text{ kg/cm}^3$
25 of pressure. The water can be jetted from orifices positioned above the web as it passes over substantially smooth non-porous supporting drum or belt. The orifices typically have a diameter ranging between 0.05 and 0.2 mm and can be suitably arranged in rows beneath a water supply pipe at intervals of 2 meters or less.

The supporting filaments and/or network sheet may be formed from a variety of
30 materials, such as polypropylene, nylon, polyester, etc. Exemplary webs (i.e., scrims) are described in U.S. Patent No. 5,525,397, the disclosure of which is herein incorporated by reference. Suitable materials which may be used to form the network sheet may be selected from, for example, polyolefins such as polyethylene, polypropylene and

polybutene; olefin copolymers formed from monomers such as ethylene, propylene and butene; olefin-vinyl ester copolymers, such as ethylene-vinyl acetate copolymers; acrylonitrile polymers and copolymers; polyesters such as polyethylene terephthalate and polybutylene terephthalate; polyamides such as nylon 6 and nylon 66; acrylonitriles; vinyl
5 polymers such as polyvinyl chloride; vinylidene polymers such as polyvinylidene chloride; modified polymers; and mixtures thereof.

The nonwoven aggregate layer used to form the present cleaning sheets typically has a relatively smooth surface apart from some gathering of the microfibers in the portions immediately adjacent to a supporting network (see, e.g., the cross-sectional view depicted in Figure 5). This is, however, not a requirement as nonwoven sheets having a relatively "wavy" surface, i.e., having a plurality of peaks and valleys with dimensions smaller than those of the cavities in the surface, may be employed. Examples of such materials are described in U.S. Patent 5,310,590, International Patent Application No. 98/52458 and Japanese Laid Open Patent Document No. 5-25763 (laid open on February
10 2, 1993), the disclosure of which is herein incorporated by reference. One method of forming such wavy surfaced sheets is to hydroentangle one or more layers of nonwoven fibers with a thermally shrinkable supporting scrim. After hydroentangling a nonwoven web with the supporting scrim the resulting structure can be subjected to a heat treatment so that the structure is dried as the scrim is simultaneously shrunk. One example of a
15 method of producing such a sheet is set forth in and Japanese Laid Open Patent Document No. 5-25763.

The outer cleaning surface of fabric layer 1 is a generally smooth and compliant (e.g., flexible) generally planar sheet for cleaning delicate surfaces (e.g., wood, glass, plastic, etc.) or hard surfaces. The cleaning sheet may include a backing layer which is
20 more rigid and/or have a greater basis weight than fabric layer to provide support and structure to the cleaning sheet. According to other alternative embodiments, a spacer or other intermediate layers may be positioned between the backing layer and the outer fabric layer.

A variety of materials are suitable for use as a backing layer in the present cleaning sheets so long as this layer has the desired degree of flexibility and is capable of providing
30 sufficient support to the sheet as a whole. Examples of suitable materials for use as a backing layer include a wide variety of lightweight (e.g., having a basis weight of about 10 to 75 g/m²), flexible materials capable of providing the sheet with sufficient strength to

resist tearing or stretching during use. The backing layer is typically relatively thin, e.g., has a thickness of about 0.05 mm to about 0.5 mm, and can be relatively non-porous. Examples of suitable materials include spunbond and thermal bond nonwovens sheets formed from synthetic and/or natural polymers. Other backing materials which can be utilized to produce the present cleaning sheets include relatively non-porous, flexible layers formed from polyester, polyamide, polyolefin or mixtures thereof. The backing layer could also be made of hydroentangled nonwoven fibers so long as it meets the performance criteria necessary for the particular application. One specific example of a suitable backing layer is a spun bond polypropylene sheet with a basis weight of about 20 to 50 g/m².

Physical Parameters of the Cleaning Sheet

The cleaning sheet typically has a relatively low overall breaking strength in order to preserve a relative amount of flexibility. The term "breaking strength" as used in this disclosure means the value of a load (i.e., the first peak value during the measurement of the tensile strength) at which the cleaning sheet begins to break when a tensile load is applied to the cleaning sheet. The breaking strength of the sheet should, however, be high enough to prevent "shedding" or tearing of the cleaning sheet during use. The breaking strength of the cleaning sheet is typically at least about 500 g/30 cm and cleaning sheets with breaking strengths of 1,500 g/30 cm to 3,000 g/30 cm are quite suitable for use with the cleaning implements described herein.

The cleaning sheet typically includes a nonwoven fiber layer which has a relatively low basis weight as the surfactant treated particle retention layer (i.e., the material on the cleaning surface of the sheet). According to a particularly suitable embodiment, the nonwoven layer has a basis weight in the range of about 30 to 250 g/m², preferably 50 to 150 g/m². A low basis weight can assist in providing a "stream-line" or compact look and feel to the cleaning sheet.

Where intended to be used with a cleaning utensil, mounting structure or the like, the cleaning sheet typically has a relatively low overall elongation to assist in resisting "bunching" or "puckering" of the cleaning sheet. The term "elongation" as used in this disclosure means the elongation percentage (%) of the cleaning sheet when a tensile load

of 500 g/30 mm is applied. For example, when designed to be used in conjunction with a mop or similar cleaning implement where the cleaning sheet is fixedly mounted, the present cleaning sheets typically have an elongation of no more than about 25% and, preferably, no more than about 15%.

5 The basis weight of the nonwoven fiber aggregate generally falls within the range of 50 to 250 g/m² and, typically is no more than 150 g/m². If the basis weight of the nonwoven fiber aggregate layer is less than about 30 g/m², dust may pass too easily through the nonwoven fiber aggregate during the cleaning operation and its dust collecting capacity may be limited. If the basis weight of the nonwoven fiber aggregate is too large,
10 e.g., substantially greater than 250 g/m², it can become more difficult to sufficiently entangle the fibers in the aggregate and the network sheet with each other to achieve a desirable degree of entanglement. In addition, the processability of the nonwoven aggregate can worsen, and shedding of the fibers from the cleaning sheet may occur more frequently. The denier of the fibers in the fiber aggregate, the length, the cross-sectional
15 shape and the strength of the fibers used in the nonwoven fiber aggregate are generally determined with an eye toward processability and cost, in addition to factors relating to performance.

 In cases where the entanglement coefficient of the fiber aggregate, which is expressed by the initial gradient of the stress-strain curve measured with respect to the
20 direction perpendicular to the fiber orientation (i.e., "CD initial modulus"), is to be set at a value not greater than 800 m, as in the cleaning sheet in accordance with the present invention, it may be difficult for a sheet, which is constituted only of a fiber aggregate, to achieve the values of the breaking strength and the elongation described above. In order to set the entanglement coefficient at a value not larger than 800 m, a network sheet and
25 the fiber aggregate can be entangled and combined with each other into a unitary body for use as the fabric layer in the cleaning sheets. By entangling the fiber aggregate with the network sheet into a unitary body, and the elongation of this layer is kept low and its processability can be enhanced. Shedding of the fibers from the cleaning sheet in accordance with the present invention can often be markedly prevented as compared with
30 a conventional entangled sheet, which is constituted only of a fiber aggregate in approximately the same entanglement state as that in the fiber aggregate of the cleaning sheet in accordance with the present invention.

If the entanglement coefficient is too small, e.g., no more than about 10 to 20 m, the fibers may not be sufficiently entangled together. In addition, the entanglement between the fibers and the network sheet will likely be poor as well. As a result, shedding of the fibers may occur frequently. If the entanglement coefficient is too large, e.g., greater than about 700 to 800 m, a sufficient degree of freedom of the fibers cannot be obtained due to too strong entanglement. This can prevent the fibers from easily entangling with dust, hair and/or other debris, and the cleaning performance of the sheet may not be satisfactory. Preferably, the cleaning sheet is formed from a nonwoven fiber aggregate with an entanglement coefficient of no more than 500 m and, more preferably, about 50 to 300 m.

The degree of the entanglement of the fibers depends on the entanglement energy applied to the fiber web during the entanglement process. For example, in the water needling process, the entanglement energy applied to the fiber web can be controlled from the view point of the type of fibers, the basis weight of the fiber web, the number and positioning of the water jet nozzles, the water pressure and the line speed among other factors.

In cases where the network sheet is a net formed from filaments of thermoplastic material, such as shown in Figure 4, the mesh, the fiber diameter, the distance between fibers (and consequently the size of the holes) and the configuration of the holes are generally determined from the view point of the local entanglement with the nonwoven fiber aggregate. Specifically, the diameter of the holes ("gaps") typically falls within the range of 5 mm to 30 mm. Stated otherwise, the distance between adjacent parallel rows of fibers commonly falls within the range of 5 mm to 30 mm, and more preferably falls within the range of 10 mm to 20 mm.

The fibers used to form the fiber aggregate are suitably made from any of a number of thermoplastic fibers such as polyesters (e.g., polyethylene terephthalate and/or polylactate), polyamides (e.g., nylon) and polyolefins (e.g., polypropylene); composite fibers thereof, divided fibers thereof, and ultra thin fibers thereof, such as produced by a melt blown process; semi-synthetic fibers such as acetate fibers; regenerated fibers such as rayon; and natural fibers such as cotton and blends of cotton and other fibers. The fibers typically have a denier of no more than about 5 and, more preferably, 0.5 to 3.

Dust Adhesion Agent

In accordance with the performance functions typically required for the present cleaning sheet, it may be advantageous to incorporate some form of dust adhesion agent in the fabric layer to enhance the dust collecting capabilities of the cleaning sheet when it is employed as a dry cleaning cloth. Herein, agents which enhance the dust collecting capabilities of the cleaning sheet in some manner are referred to as "dust adhesion agents." For example, the fabric layer may be a nonwoven fiber aggregate layer which includes a lubricant and/or surface-active agent. The surface active agent can improve the surface physical properties of the fiber aggregate and enhance the cleaning sheet's ability to absorb dust. The inclusion of lubricant can also impart gloss to a surface being cleaned with the sheet as well as enhancing the dust collecting efficiency of the cleaning sheet.

Generally, the entire fabric layer will be treated with the dust adhesion agent. Although the dust adhesion agent and surfactant treatments may be applied in any order, commonly dust adhesion agent is applied to the entire fabric layer and the surfactant. The dust adhesion agents are commonly added in an amount of 0.1 to 20 wt.% (add-on wt.% based on the weight of the fabric layer being treated). More typically, no more than about 10 wt.% (add-on basis) of the dust adhesion agent is added to the fabric layer. Particularly suitable embodiments of the present cleaning sheets include a fabric layer which has been treated with about 3 to about 10 wt.% (add-on basis) of the dust adhesion agent. As will be understood by those skilled in the art, the amount of dust adhesion agent utilized will depend on the specific type of fabric material being treated, the specific dust adhesion agent employed and the type of application the cleaning sheet is designed to be utilized for, among other factors.

Suitable lubricants for use as dust adhesion agents in the present cleaning sheets include mineral oils, synthetic oils, silicone oils. Examples of mineral oils which may be employed include paraffin hydrocarbons, naphthenic hydrocarbons, and aromatic hydrocarbons. Suitable synthetic oils include alkylbenzene oils, polyolefin oils, polyglycol oils and the like. Suitable silicone oils include acrylic dimethyl polysiloxane, cyclic dimethyl polysiloxane, methylhydrogen polysiloxane, and various modified silicone oils.

The mineral oils, synthetic oils and silicone oils generally have a viscosity of 5 to 1000 cps, particularly 5 to 200 cps (at 25°C). If the viscosity is lower than about 5 cps, the dust-adsorbing property can be decreased. If the viscosity is greater than about 1000 cps,

the lubricant can sometimes fail to spread uniformly on the fibers. In addition, friction coefficient to the surface to be cleaned may increase, possibly causing damage of the surface to be cleaned. The mineral oils, synthetic oils and silicone oils commonly have a surface tension of 15 to 45 dyn/cm, particularly 20 to 35 dyn/cm (at 25°C). If the surface tension is lower than 15 dyn/cm, the dust-adsorbing property of the treated fabric can become worse, and if it is higher than 45 dyn/cm, the lubricant sometimes fails to spread uniformly on the fibers constituting the nonwoven fabric.

As indicated above, the dust adhesion agents may include a surfactant. This surfactant can be in addition to and/or different from the surfactant which is present in the sheet to enhance its wet cleaning capability. The surfactant component of the dust adhesion agent typically includes cationic and/or nonionic surfactant(s). The surfactant component generally makes up no more than 5-10 wt.% of the dust adhesion agent. Thus, a typical cleaning sheet which includes 5 wt.% dust adhesion agent (add-on wt.% based on the dry weight of the fabric layer being treated) generally contains no more than about 0.5 wt.% surfactant which is present as a component of the dust adhesion agent. Examples of suitable cationic surfactants include mono(long-chain alkyl/alkenyl)trimethylammonium salts, di(long-chain alkyl/alkenyl)dimethyl-ammonium salts, and mono(long-chain alkyl/alkenyl)dimethylbenzylammonium salts, each having an alkyl or alkenyl group containing 10 to 22 carbon atoms. Examples of suitable nonionic surfactants for inclusion as a dust adhesion agent include polyethylene glycol ethers, e.g., polyoxyethylene (6 to 35 mol) primary or secondary long-chain (C₈ - C₂₂) alkyl or alkenyl ethers, polyoxyethylene (6 to 35 mol) (C₈ - C₁₈) alkyl phenyl ethers, polyoxyethylene polyoxypropylene block copolymers, and those of polyhydric alcohol type, e.g., glycerol fatty acid esters, sorbitan fatty acid esters, and alkyl glycosides. It is preferred that the surface active agent contains 5% by weight or less of water to enhance effective cleaning.

The dust adhesion agents typically include a minor amount of a surfactant together with a lubricant. Typically, the dust adhesion agents include at least about 70 wt.% and, preferably, at least about 80 wt.% of a lubricant made up of mineral oil, synthetic oil and/or silicone oil. One example of a suitable dust adhesion agent is made up of 90-95 wt.% of a mineral oil such as petrolatum or a related paraffinic hydrocarbon together with 5-10 wt.% of a nonionic surfactant, e.g., a polyoxyethylene alkyl ether such as a polyoxyethylene (C₁₂-C₁₄) alkyl ether having an average of 3-5 oxyethylene subunits.

The present cleaning sheets typically are capable of picking up and retaining at least about at least about 15 g/m² of dust. Stated otherwise, the cleaning sheet has a particle retention capacity of at least about 15 g/m². Preferably, the cleaning sheet has a particle retention capacity of at least about 20 g/m², more preferably at least about 25 g/m².

The cleaning sheet may be used alone (e.g., as a rag) or in combination with another implement(s) to clean a surface. Examples of suitable cleaning implements which can include the present cleaning sheet include mops, gloves, dusters, rollers, or wipes. For example, the cleaning sheet may be attached to a mounting structure, such as the head of a mop. The head typically includes a carriage providing fasteners for mounting the sheet. An elongate rigid member (such as a segmented handle) may be attached to carriage by a mounting structure. The mounting structure can include a yoke having a y-shaped end pivotally mounted to a socket (e.g., a ball joint). An adapter can be threadably attached to an arm of a handle. According to alternative embodiments, the cleaning utensil may be a broom, brush, polisher, handle or the like adapted to secure the cleaning sheet.

The cleaning sheet may be attached to a head of a cleaning utensil, such as a dust mop. The cleaning pad typically includes a layer of nonwoven microfibers which has a discontinuous pattern of regions in which a surfactant has been deposited on the microfibers to enhance the wet cleaning capability of the sheet. Debris can be forced and/or drawn into the pores in the outer cleaning surface and become entrapped between the fibers of the nonwoven aggregate layer when the pad is moved along a surface to be cleaned. As discussed elsewhere herein, the cleaning sheet is generally somewhat flexible to permit surfaces with different contours (e.g., smooth, irregular, creviced, etc.) to be cleaned. According to an alternative embodiment, the cleaning sheet may be semi-rigid, e.g., where it is designed to be utilized for cleaning planar surfaces.

The cleaning sheet may be attached to the cleaning utensil by any of a variety of fasteners (e.g., friction clips, screws, adhesives, retaining fingers, etc.) as are known to one of skill that reviews this disclosure. According to other alternative embodiments, the cleaning sheet may be attached as a single unit, or as a plurality of sheets (e.g., strips or "hairs" of a mop).

According to another embodiment, the components of the cleaning utensil, namely the mounting structure, adapter and handle may be provided individually or in combinations as a kit or package. The components of the cleaning utensil may be readily,

easily and quickly assembled and disassembled in the field (e.g., work site, home, office, etc.) for compactability and quick replacement. The components of the cleaning utensil may also be provided in a pre-assembled and/or unitary condition. In one particularly suitable embodiment, the cleaning sheet is configured for use with the Pledge® Grab-It™ sweeper commercially available from S.C. Johnson & Son, Inc. of Racine, Wisconsin.

To clean a surface, a cleaning sheet can be secured to the head of a mop. The sheet may be brought into contact with surface and moved along this surface (e.g., in a horizontal direction, vertical direction, rotating motion, linear motion, etc.). Debris from surface is commonly entrained within the cavities in the fabric layer. Finer particulate material can become entrapped in pores between the fibers of the fabric. After use, the sheet may be removed from mop for disposal or cleaning (e.g., washing, shaking, removing debris, etc.) prior to reuse. According to an alternative embodiment, the cleaning sheet may be used alone (e.g., hand held) to clean the surface.

Test Methods:

(1) Breaking strength (cross machine direction)

From each of the sheets, samples having a width of 30 mm were cut out in the direction perpendicular to the fiber orientation in the sheet, i.e., in the cross machine direction. The sample was chucked with a chuck-to-chuck distance of 100 mm in a tensile testing machine and elongated at a rate of 300 mm/min in the direction perpendicular to the fiber orientation. The value of load at which the sheet began to break (the first peak value of the continuous curve obtained by the stress/strain measurement) was taken as the breaking strength.

(2) Elongation at a load of 500 g/30 mm

The elongation of the sample, at a load of 500 g in the measurement of the breaking strength in the cross machine direction described above, was measured. For the purposes of this application, "elongation" is defined as the relative increase in length (in %) of a 30 mm strip of cleaning sheet material when a tensile load of 500 g is applied to the strip.

(3) Entanglement coefficient

The network sheet is removed from the nonwoven fiber aggregate. Where the network sheet has a lattice-like net structure, this is typically accomplished by cutting the fibers which make up the network sheet at their junctures and carefully removing the fragments of the network sheet from the nonwoven fiber aggregate with a tweezers. A

sample having a width of 15 mm is cut out in the direction perpendicular to the fiber orientation in the sheet (i.e., in the cross machine direction). The sample is chucked with a chuck-to-chuck distance of 50 mm in a tensile testing machine, and elongated at a rate of 30 mm/min in the direction perpendicular to the fiber orientation (in the cross machine direction). The tensile load value F (in grams) with respect to the elongation of the sample is measured. The value, which is obtained by dividing the tensile load value F by the sample width (in meters) and the basis weight of the nonwoven fiber aggregate W (in g/m^2), is taken as the stress, S (in meters). A stress-strain curve is obtained by plotting stress ("S") against the elongation ("strain" in %).

$$\text{Stress } S [\text{m}] = (F/0.015)/W$$

For a nonwoven fiber aggregate, which is held together only through the entanglement of the fibers, a straight-line relationship is generally obtained at the initial stage of the stress-strain (elongation) curve. The gradient of the straight line is calculated as the entanglement coefficient E (in meters). For example, in the illustrative stress-strain curve shown in FIG. 6 (where the vertical axis represents the stress, the horizontal axis represents the strain, and O represents the origin), the limit of straight-line relationship is represented by P , the stress at P is represented by S_p , and the strain at P is represented by γ_p . In such cases, the entanglement coefficient is calculated as $E = S_p/\gamma_p$. For example, when $S_p = 60 \text{ m}$ and $\gamma_p = 86\%$, E is calculated as $E = 60/0.86 = 70 \text{ m}$. It should be noted that the line OP is not always strictly straight. In such cases, the line OP is approximated by a straight line.

The articles and methods of the present invention may be illustrated by the following examples, which are intended to illustrate the present invention and to assist in teaching one of ordinary skill how to make and use the invention. These examples are not intended in any way to limit or narrow the scope of the present invention.

Example 1

A scrim supported polyester fiber nonwoven cloth can be formed by hydroentangling a polypropylene scrim sandwiched between two carded polyester fiber webs. The polypropylene scrim is a grid of 0.2 mm diameter fibers with a 9 mm spacing between adjacent fibers and had a basis weight 5 g/m^2 . The two carded polyester webs are formed from 1.5 denier polyethylene terephthalate ("PET") fibers 51 mm in length. Each of the carded polyester webs has a basis weight of 24 g/m^2 . The combination of the

polypropylene scrim and the two carded polyester webs is subjected to water needling ("hydroentanglement") under low energy conditions to produce a unitary nonwoven sheet having a breaking strength of 1500 to 2500 g/30 mm (CD) and an elongation (at 500g/30 mm) of 4%. The hydroentanglement is conducted such that after removal of the supporting scrim from the unitary nonwoven sheet, the remaining hydroentangled polyester web has an entanglement coefficient of 65-70 m.

A dust adhesion agent (viscosity: 125 cps, surface tension: 30 dyn/cm) consisting of 95% of liquid paraffin and 5% of nonionic surfactant (polyoxethylene (average mol number: 3.3) (C₁₂-C₁₃) alkyl ether) is then applied to the reinforced nonwoven aggregate to enhance its dust collecting capabilities. The dust adhesion agent is commonly applied uniformly to one surface of the nonwoven aggregate in an amount which results in 5 wt.% (based on the dry weight of the fiber aggregate) dust adhesion agent being deposited on the fibers of the aggregate.

A mixture of a volatile solvent, such as ethanol, and polyoxypropylene-polyoxyethylene block copolymer (available under the tradename Pluronic[®] P105 from BASF Corp., Mount Olive, NJ) is then imprinted onto one surface of the fabric in a discontinuous pattern of dots, such as depicted in Figure 1. The amount of the mixture applied to the fabric is such that 3 wt.% copolymer (based on the dry weight of the nonwoven fabric) is present in the sheet after the volatile solvent has been removed. The "dotted regions" typically contains the copolymer deposited on fibers in the interior of the fabric layer as well as on fibers on the surface of the aggregate (e.g., as depicted in Figure 2). The solvent is removed by passing a stream of air over the surfaces of the fabric.

Example 2

Another example of a cleaning sheet can be produced by imprinting a mixture of volatile solvent such as ethanol and a hydroxyalkyl amide surfactant, e.g., lauramide DEA (available under the tradename Ninol[®] 96-SL from Stepan Co., Northfield, IL) onto a woven microfiber fabric, such as a sheet of Scotchbrite[™] material (available from 3M Corporation, St. Paul, MN). An amount of a 50 wt.% solution of Ninol[®] 96-SL sufficient to result in a sheet with 5 wt.% Ninol[®] 96-SL (based on the dry weight of the woven fabric) is imprinted onto one surface of the fabric in a regular pattern of wavy lines, such as depicted in Figure 3. The volatile solvent (ethanol) can be removed by passing a stream

of air over the sheet until the weight of the fabric has been reduced by an amount corresponding to the amount of ethanol applied. If desired, the treated fabric layer may be heated as well to speed the removal of the ethanol.

Example 3

5 Polyester fiber web having a basis weight of 10 g/m^2 can be prepared by a conventional carding machine from polyester fiber 51 mm in length and 1.5 denier in diameter. The fiber web is lapped in 3 layers (30 g/m^2) and layers of the lapped fiber web are overlaid on the upper and lower sides, respectively, of a biaxially shrinkable polypropylene net (mesh: 5, fiber diameter: 0.215 mm). The resulting combination is
10 subjected to a water needling process to entangle the fiber webs and the net. The water pressure used in the water needling process is about $35\text{-}40 \text{ kg/cm}^2$ at a nozzle pitch of 1.6 mm while the combination of fiber web and polypropylene net is moved past the nozzles at a line speed of 5m/min. The hydroentangled combination is then subjected to heat treatment with hot air (130°C) for about 1-2 minutes to simultaneously dry the web and
15 shrink the polypropylene net. This produces a reinforced nonwoven aggregate having an area shrinkage coefficient of 10% in which depressions and projections are formed over the major surfaces. If desired, 5 wt.% (based on the dry weight of the fiber aggregate) of a dust adhesion agent (viscosity: 125 cps, surface tension: 30 dyn/cm) consisting of 95% of liquid paraffin and 5% of nonionic surfactant (polyoxethylene (average mol number: 3.3)
20 ($\text{C}_{12}\text{-C}_{13}$) alkyl ether) can be applied to the reinforced nonwoven aggregate to enhance its dust collecting capabilities. A 60°C melt of PEG-20 stearate (mp - 41°C ; HLB 15.7; available from Stepan Co., Northfield, IL) is then applied to one surface of the web in a discontinuous regular pattern of dots covering 6% of the surface. The surfactant is applied in an amount such that the surfactant makes up 5 wt.% of the total weight of the nonwoven
25 web.

INDUSTRIAL APPLICABILITY

The cleaning sheet of the present invention can be manufactured using commercially available techniques, equipment and material. In addition, the cloth may be used on a variety of surfaces such as plastic, wood, carpet, fabric, glass and the like.

30 Cleaning implements and methods of cleaning surfaces using the cleaning sheet are also provided herein. The cleaning implement may be produced as an intact implement or in the form of a cleaning utensil kit. Intact implements include gloves, dusters and rollers. Kits according to the present invention, which are designed to be used for cleaning

surfaces, commonly include a cleaning head and a cleaning sheet capable of being coupled to the cleaning head. In addition, the kit can include a yoke capable of installation on the cleaning head and an elongate handle for attachment to the yoke. Whether provided as a completely assembled cleaning implement or as a kit, the cleaning implement may include
5 a cleaning head that allows the cleaning sheet to be removably attached to the cleaning head.

While the making and using of various embodiments are discussed in some detail herein, it should be appreciated that the present invention provides inventive concepts which can be embodied in a wide variety of specific contexts. The specific embodiments
10 discussed herein are merely illustrative of specific ways to make and use cleaning sheets and are not meant to limit the scope of the invention. Various modifications and combinations of the illustrative embodiments, as well as other embodiments of the invention, will be apparent to persons skilled in the art upon reference to the description.

WHAT IS CLAIMED IS:

1. A dry cleaning sheet with wet cleaning capability comprising:
a fabric layer comprising 1 to 10 wt.% surfactant and a plurality of
microfibers;
5 wherein the fabric layer has a basis weight of 30 to 250 g/m²; and the
surfactant is a solid or paste at 25°C and has a water solubility of no more than 20 wt.% at
25°C.
- 10 2. The cleaning sheet of claim 1 wherein the microfibers have a denier of 0.1 to 2.
3. The cleaning sheet of claim 1 wherein the fabric layer is a woven fabric layer.
4. The cleaning sheet of claim 1 wherein the fabric layer is a nonwoven fabric layer.
- 15 5. The cleaning sheet of claim 4 wherein the nonwoven fabric layer has an
entanglement coefficient of 20 to 800 m.
6. The cleaning sheet of claim 4 wherein the nonwoven fabric layer includes a
network sheet.
- 20 7. The cleaning sheet of claim 1 wherein a 0.1 wt.% aqueous solution of the
surfactant has a Ross Miles foam height of no more than 100 mm.
8. The cleaning sheet of claim 1 wherein the surfactant is nonionic surfactant, anionic
25 surfactant, or a mixture thereof.
9. The cleaning sheet of claim 8 wherein the nonionic surfactant includes ethoxylated
alkanol, ethoxylated alkenol, polyoxypropylene-polyoxyethylene block copolymer,
polyethyleneglycol monoester, alkylphenoxy-polyethyleneoxide, fatty acid glycol
30 monoester, paraffinic ethoxylate carboxylate, alkyldimethylamine oxide, fatty acid
hydroxyalkyl amide or a mixture thereof.

10. The cleaning sheet of claim 8 wherein the nonionic surfactant has an HLB of 10 to 18.

11. The cleaning sheet of claim 8 wherein the nonionic surfactant includes ethoxylated fatty alcohol having an alkyl group with 16 to 18 carbon atoms.

12. The cleaning sheet of claim 8 wherein the nonionic surfactant includes polyoxypropylene-polyoxyethylene block copolymer having an HLB of 12 to 18.

13. The cleaning sheet of claim 8 wherein the nonionic surfactant includes a polyethyleneglycol fatty acid monoester and the fatty acid has 12 to 18 carbon atoms.

14. The cleaning sheet of claim 8 wherein the anionic surfactant includes fatty acid salt, alkanesulfonate salt, alkylbenzenesulfonate salt, alkanol sulfate salt, or a mixture thereof.

15. The cleaning sheet of claim 14 wherein the fatty acid salt includes calcium salt of fatty acid, magnesium salt of fatty acid or a mixture thereof.

16. The cleaning sheet of claim 1 wherein the fabric layer includes at least one dust retention surface having a plurality of depressions.

17. The cleaning sheet of claim 1 wherein the surfactant is deposited on no more than 20% of the microfibers.

18. The cleaning sheet of claim 1 wherein the surfactant is deposited on microfibers in discontinuous regions of the fabric layer.

19. The cleaning sheet of claim 1 coupled to a mounting structure.

20. The cleaning sheet of claim 1 having a breaking strength of 500 to 3000 g/mm.

21. The cleaning sheet of claim 1 having an elongation of no more than 25 % at a load of 500 g/30 mm.

22. The cleaning sheet of Claim 1 wherein the fabric layer has a particle retention capacity of at least 20 g/m².

23. The cleaning sheet of Claim 1 wherein the surfactant has a melting point of at least 35°C.

24. A dry cleaning sheet with wet cleaning capability comprising:
a fabric layer comprising 1 to 10 wt.% surfactant and a plurality of microfibers;
wherein the microfibers having a denier of no more than 3; and the surfactant is a solid or paste at 25°C and an HLB of 10 to 18.

25. A dry cleaning sheet with wet cleaning capability comprising:
a nonwoven fabric layer comprising 2 to 7 wt.% surfactant and a plurality of microfibers having a denier of no more than 2;
wherein the nonwoven fabric layer has a basis weight of 50 to 150 g/m²;
the surfactant has a melting point of at least 35°C and a water solubility of no more than 20 wt.% at 25°C; and the surfactant includes at least 50 wt.% ethoxylated alkanol.

26. A cleaning utensil kit for cleaning surfaces comprising:
a cleaning head; and

a dry cleaning sheet adapted for coupling to the head including:
a fabric layer comprising 1 to 10 wt.% surfactant and a plurality of microfibers;
wherein the fabric layer has a basis weight of 30 to 250 g/m²; and the surfactant is a solid or paste at 25°C and has a low water solubility.

27. A cleaning implement for cleaning surfaces comprising:

a dry cleaning sheet adapted for coupling to the head, the sheet including:

a fabric layer comprising 1 to 10 wt.% surfactant and a plurality of microfibers;

5 wherein the fabric layer has a basis weight of 30 to 250 g/m²; and the surfactant is a solid or paste at 25°C and has a low water solubility.

28. A method of cleaning a surface comprising contacting said surface with a dry cleaning sheet which includes a fabric layer comprising 1 to 10 wt.% surfactant and a plurality of microfibers;

10

wherein the fabric layer has a basis weight of 30 to 250 g/m²; and the surfactant is a solid or paste at 25°C and has a low water solubility.