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(54) **Title:** DRY WIPE

(57) **Abstract:** A bulky fibrous fabric is provided, made by a process comprising obtaining an unbonded, consolidated batt of fibers wherein each fiber has a ribbon-shaped cross-section, and needling said batt to obtain the bulky fibrous fabric. The fabric has a surface area of at least 2 m^2/g and a thickness/basis weight ratio of at least 0.005 $mm/g/m^2$ (7 $mil/oz/yd^2$). The fabric has utility particularly as a dry wipe for cleaning and dusting.

DRY WIPE

FIELD OF THE INVENTION

The invention relates to a needled fibrous batt made from fibers having a ribbon-shaped cross-section.

BACKGROUND OF THE INVENTION

There exists a need for a material in the form of a dry wipe for dusting and cleaning which attracts and entraps dust and dirt particles during use more effectively than existing dry wipes and which may be manufactured more economically than existing dry wipes.

Nonwoven dry wipes containing spunlaced layers of polyester web and scrim are commercially available. Examples of such dry wipes are Swiffer®, available from The Procter & Gamble Company, Cincinnati, Ohio, and Grab-It®, available from S. C. Johnson & Son, Inc., Racine, Wisconsin, which are generally made by needling round polyester staple fibers into a scrim. These wipes are electrostatically charged to attract dirt and dust, and the three-dimensional structure of the webs used is open so that dirt particles are trapped by the wipes. Another example of a dry dust wipe is Scotch-Brite®, available from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota, made from spunlaced webs of polyester staple fibers having longitudinal grooves therein.

U.S. Patent number 5,290,628 (Lim et al.) discloses a process for hydraulically needling a web of staple fibers into an unbonded flash spun web made of continuous plexifilaments to form a spunlaced nonwoven fabric. The flash spun web may optionally be bonded to increase the level of permeability of the nonwoven fabric. Disclosed as end uses for the nonwoven fabric are filtration applications, and bulky, downproof and featherproof barrier liners for garments, sleeping bags, pillows, comforters and the like.

U.S. Patent number 4,704,321 (Zafiroglu) discloses a nonwoven fabric, useful as a wipe-cloth, comprising a layer of nonbonded, polyethylene plexifilamentary film-fibril strands, the layer being stitched through with thread that forms spaced apart rows of stitches extending along the length of the fabric. Zafiroglu found that standard thermally bonded plexifilamentary sheets were not functional for wiping cloths because after thermal bonding to generate structural integrity the dust retention was inadequate, and the non thermally bonded, cold consolidated sheet lacked sufficient surface stability for a wiping cloth.

Japanese patent application Hei 4-196066, assigned to Japan Vilene Co. Ltd., discloses a nonwoven fabric cleaning wipe having superior dust attracting ability, and a process for making such a wipe.

SUMMARY OF THE INVENTION

The invention provides a bulky fibrous fabric comprising a batt of fibers each fiber having a ribbon-shaped cross-section, the batt having a surface area of at least 2 m^2/g and a thickness/basis weight ratio of at least 0.005 $mm/g/m^2$.

In another embodiment of the invention, a bulky fibrous fabric is provided by a process comprising:

a) obtaining an unbonded, consolidated batt of fibers wherein each fiber has a ribbon-shaped cross-section; and
b) needling said batt to obtain the bulky fibrous fabric having a surface area of at least 2 m^2/g and a thickness/basis weight ratio of at least 0.005 $mm/g/m^2$.

DETAILED DESCRIPTION OF THE INVENTION

The process by which the bulky fibrous fabric of the invention is made will now be described in detail. A batt of fibers, each individual fiber having a ribbon-shaped cross-section, is obtained. By “ribbon-shaped” is meant that the average aspect ratio of the individual fiber cross-section is between 1.4 and 6.8. The batt of fibers may be obtained by a variety of known methods. One known method is for different cross-sectional shaped melt-spun fibers, such as star-shaped fibers, to be spunlaced and subsequently broken into smaller ribbon-shaped fibers.

Preferably, the batt consists of overlapping continuous plexifilamentary film-fibril strands, formed by flash-spinning techniques generally described in U.S. Patent Number 3,851,023 (Brethauer et al.), herein incorporated by reference. The film-fibrils are very thin ribbon-like fibrous elements, which are generally less than 20 microns thick. The cross-section of each fiber in a plexifilamentary strand is generally ribbon-shaped.

Preferably, the flash-spun batt is formed from polyolefin polymer, and more preferably, high density polyethylene polymer. The spin agent with which the polymer is mixed is preferably a blend of pentane and cyclopentane. The spin agent may also be a refrigerant such as Freon®, available from E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware.

In order to achieve the desired bulkiness in the final product, the percentage of polymer in the polymer-spin agent mixture is preferably between 15 and 25%, most preferably 17%. The temperature of the polymer and spin agent mixture just prior to being emitted through the spin orifice should be maintained at between 185 and 200 degrees C, most preferably 190 degrees C.

As described in U.S. Patent number 3,851,023, the plexifilamentary film-fibril strands are electrostatically charged in order to pin them to the moving belt on which they are collected as they are spun. The electrostatic charge imparted is high enough to overcome the vapor blast or high turbulence that may exist in the web forming chamber.

By "consolidated" is meant that the as-formed batt has been lightly compressed by a nip roll so that it may be handled as a sheet. By "unbonded" is meant that the batt has not been further bonded by chemical or thermal means, such as by compaction by heated rolls or plates, so that the batt has not become a coherent sheet. In the preferred embodiment in which the batt is obtained by flash spinning, the individual plexifilamentary webs which overlap one another to make up the unbonded, consolidated batt are held together in such a way that the batt may be handled as a sheet but the individual webs may be easily pulled away from the surface of the batt.

The batt is needled in order to form the bulky fibrous fabric of the invention. The needling may take the form of hydroentangling, such as described in U.S. Pat. No. 3,485,706. As stated in U.S. Pat. No. 3,485,706, the hydroentangling is carried out by subjecting the batt to high pressure liquid streams of at least 200 psig while supported by an apertured member, such as perforated plate or woven wire screen. The number of jets, jet type, jet pressure and apertured member can be varied to achieve various fabric strength, surface stability and thickness.

Preferably, the needling is carried out by needlepunching in a needle machine to obtain the fabric of the invention having a thickness of at least 0.20 millimeters, a basis weight of between 37 and 78 g/m^2, and a thickness/basis weight ratio of at least 0.005 mm/g/m^2 (7 mil/oz/yd^2). The needle density, or "punch density," is between 60 and 500/cm^2, preferably between 200 and 300/cm^2, on each side of the batt. The needle penetration is between 5 and 10 mm on each surface of the batt, preferably about 5 mm. The needle pattern is random such that the needle punches are approximately evenly spaced across both surfaces of the batt.

Since the bulky fibrous fabric of the invention is obtained by simply needling an unbonded, consolidated batt of fibers, the bulky fibrous fabric may be manufactured more economically than existing dry dust wipes made by needling staple fibers into a scrim.

TEST METHODS

Basis Weight was determined by ASTM D-3776, which is hereby incorporated by reference, and is reported in g/m^2.

Tensile Strength was determined by ASTM D 5035-95, which is hereby incorporated by reference, with the following modifications. In the test a 2.54 cm by 20.32 cm (1 inch by 8 inch) sample was clamped at opposite ends of the sample. The clamps were attached 12.7 cm (5 inches) from each other on the sample. The sample was pulled steadily at a speed of 5.08 cm/min (2 inches/min) until the sample broke. The force at break was recorded in pounds/inch and converted to Newtons/cm as the breaking tensile strength.

Thickness was determined by ASTM D177-64, which is hereby incorporated by reference, and is reported in millimeters.

Grab Tensile Strength was determined by ASTM D 5034-95, which is hereby incorporated by reference, recorded in pounds/inch and converted to Newtons/cm.

Elongation to Break of a sheet is a measure of the amount a sheet stretches prior to breaking in a strip tensile test. A 2.54 cm (1 inch) wide sample is mounted in the clamps, set 12.7 cm (5 inches) apart, of a constant rate of extension tensile testing machine such as an Instron table model tester. A continuously increasing load is applied to the sample at a crosshead speed of 5.08 cm/min (2 inches/min) until failure. The measurement is given in percentage of stretch prior to failure. The test generally follows ASTM D 5035-95.

Grab Elongation to Break was determined by ASTM D5034-95, which is hereby incorporated by reference, and recorded in %.

Density was calculated from measured basis weight divided by measured thickness and is reported in gram/cm^3.

Void Fraction was calculated as (1- calculated density/0.95)x100 and is reported in %.

Wiping Performance Test is a measure of a material's cleaning performance as a dust mop. For the test results reported herein, three test environments were used, referred to as Home, Light Industrial and Heavy Industrial. The Home environment was the floor of an office area which was cleaned daily. The Light Industrial environment was a busy hallway in a manufacturing area which had more traffic than the Home environment and was not cleaned daily. The Heavy Industrial environment had forklift truck traffic and was never cleaned. The materials to be tested were cut into samples measuring approximately 5 inches by 11 inches. Each sample was weighed and the weight recorded. Two samples to be compared were secured to the bottom surface of a dry mop with a flat, smooth rubber bottom surface. The mopping surface of the mop was approximately 10 inches by 3 inches. The mop was pushed over a fifty foot section of the floor. The samples were then removed from the mop and folded in such a way that the dust collected by each sample was held within that sample. Each sample was reweighed to determine the amount of dust collected by that sample. The percent performance was determined by dividing the dust collected by the dust collected by the incumbent, or comparison sample, and multiplying by 100%. This means that the incumbent will always have 100% performance, while the invention example will have a percent relative to the incumbent. Values less than 100% indicate inferior performance, while values greater than 100% indicate superior performance. Seven to ten sample pairs were run for each environment and the result is the average.

<u>Fiber Surface Stability Test</u> is a measure of how cohesive a surface is when exposed to a destructive external force. For this test, the samples were exposed to standard Scotch™ transparent tape, available from 3M, St. Paul, Minnesota. Four measurements were taken on one surface of the sample and four on the other. Eight (8) seven-inch pieces of tape were cut and weighed, and the initial weight recorded. Each piece of tape was applied to the surface to be tested and rubbed evenly to insure contact between the tape and the sample surface. The tape is then pulled away from the sample, then reapplied and pulled away for a total of five times for each piece of tape. Each piece of tape is weighed a second time and the final weight recorded. The final and initial weights for each piece of tape were used to calculate the weight of the fibers removed from the sample surface. An average was calculated for each side of the sample. The more fiber lost by the surface of the sample, the more unstable the surface of the sample is. The results are reported in grams.

<u>Surface Area</u> is calculated from the amount of nitrogen absorbed by a sample at liquid nitrogen temperatures by means of the Brunauer-Emmet-Teller equation and is given in m^2/g. The nitrogen absorption is determined using a Stohlein Surface Area Meter manufactured by Standard Instrumentation, Inc., Charleston, West Virginia. The test

method applied is found in the J. Am. Chem. Soc., V. 60 p. 309-319 (1938).

EXAMPLES 1-13

Flash spun unbonded batts were obtained by flash spinning high density polyethylene at various concentrations in a blend of pentane and cyclopentane spin agent at various temperatures by a process as described in Brethauer. The batts were lightly consolidated using a nip roll. The spinning conditions (percent polymer in spin agent and spinning temperature) and properties measured for each of these batts are listed as Comparative Examples 1-6 in Table 1.

The batts were then needlepunched in a needle machine using a 4500 needles per meter board on each of the top and bottom surfaces. Each batt was needled at a punch density of $60/cm^2$ on each side and a needle penetration of 10 mm on the top surface and 5 mm on the bottom. A random needle pattern was used. The output speed was 6-7 meters per minute. The properties of these needlepunched batts, or nonwoven fabrics, are listed as Examples 1-9 in Table 1. Examples 1-9 are the nonwoven fabrics resulting from needlepunching the batts of Comparative Examples 1-6. Comparative Examples 1, 2, 4 and 6 provided the starting material for Examples 1, 2, 5 and 9, respectively. Comparative Example 3 provided the starting material for both Examples 3 and 4. Comparative Example 5 provided the starting material for Examples 6, 7 and 8.

The properties of nonwoven fabrics Swiffer® (commercially available from The Procter and Gamble Company, Cincinnati, Ohio) and Grab It® (commercially available from S. C. Johnson & Son, Inc., Racine, Wisconsin) were measured and listed in Table 1 as Comparative Examples 7 and 8.

The thickness/basis weight (BW) ratio is a measure of the bulkiness of the fabric. The higher the thickness/BW, the bulkier the fabric. The thickness/BW of the unbonded, unneedled batt (Comparative Examples 1-6) ranges from 4.5 to 5.2 depending on the basis weight and spinning conditions. The thickness/BW of needlepunched fabric (Examples 1-9) ranges from 7.2 to 7.9. The increase in thickness/BW of the needlepunched fabric is attributed to fiber entanglement caused by the action of the needles. This phenomenon is contrary to typical needlepunching of webs where the needles cause the web to consolidate and lower the thickness. This increased thickness/BW ratio, or bulkiness, is important for the wiping performance of the fabric of the invention, since it provides greater capacity for the fabric to capture and store dust and dirt particles.

Slight increases in the mechanical properties of Examples 1-9 as compared with Comparative Examples 1-6, specifically grab tensile strength, grab elongation to break, tensile strength and elongation to break, are attributed to the fiber entanglements caused by the needlepunching process. The mechanical properties are increased with increasing basis weight. A 54 g/m^2 needlepunched fabric has a similar range of mechanical properties as the current incumbent wipe products.

Table 2 illustrates the effects on surface stability and wiping performance when the spinning conditions are held constant and the needling density and penetration are varied. Examples 8 and 10-13 are based on the starting batt material of Comparative Example 5, and each is needlepunched at a different needle density and penetration (on the upper and lower sides), listed in Table 2. Surface area measurements are also included in Table 2.

Surface area measurements were made on the existing dust wipe materials, Swiffer® and Grab-It® (Comparative Examples 7 and 8), and the result was 0.0 m^2/g, meaning less than 0.1 m^2/g.

Table 1

Example	Comparison 1	Comparison 2	Comparison 3	Comparison 4	Comparison 5	Comparison 6	1	2
Spun condition (% polymer, degrees C)	17/190	17/197	17/200	20/200	17/190	17/190	17/190	17/197
Basis Weight (g/m^2)	41	41	54	51	54	78	37	41
Thickness (mm)	0.159	0.155	0.203	0.198	0.203	0.264	0.221	0.236
Thickness/Basis Weight (m^3/g)	3.90E-06	3.80E-06	3.80E-06	3.90E-06	3.80E-06	3.40E-06	6.00E-06	5.80E-06
Density (g/cm^3)	0.257	0.263	0.267	0.257	0.267	0.295	0.169	0.172
Void Fraction (%)	73	72.3	71.9	72.9	71.9	68.9	82.2	81.9
Grab Tenacity MD/CD (N/cm)	5./10	5./9	12./46	9./47	19/28	24/46	10./12	10./16
Grab Elongation MD/CD (%)	44/64	43/57		50/34	40/51	41/53	45/39	43/45
Tensile MD/CD (N/cm)	1.9/2.3	1.7/1.7	2.6/8.9	2.6/8.8	3.5/4.5	6.6/6.6	1.9/3.1	2.6/3.3
Elongation MD/CD (%)	4./15	6./13	15/23	15/23	9./13	9.4/11.4	26/27	29/28
Fiber Surface Stability:								
Belt side (g)	0.0975	0.0614	0.0461	0.295	0.554	0.149	0.0496	0.0505
Top side (g)	0.302	0.143	0.0667	0.0646	0.156	0.276	0.0657	0.0708
Wiping Performance (%):								
Home environment		81	110		76	90	105	170
Light Industrial		81	100	87	82	90	100	130
Heavy Industrial		76	100	85	100	85	75	80

Table 1, continued

Example	3	4	5	6	7	8	9	Comparison 7	Comparison 8
Spun condition (% polymer, degrees C)	17/200	17/200	20/200	17/190	17/190	17/190	17/190		
Basis Weight (g/m^2)	49	51	51	56	48	51	78	64	58
Thickness (mm)	0.287	0.274	0.292	0.307	0.251	0.3	0.414	0.297	0.305
Thickness/Basis Weight (m^3/g)	5.90E-06	5.40E-06	5.70E-06	5.50E-06	5.20E-06	5.90E-06	5.30E-06	4.60E-06	5.30E-06
Density (g/cm^3)	0.171	0.186	0.174	0.183	0.192	0.17	0.189		
Void Fraction (%)	82	80.4	81.7	80.7	79.8	82.1	80.1		
Grab Tenacity MD/CD (N/cm)	18/24	18/21	30/44			30/35	44/53	16/9	28/9
Grab Elongation MD/CD (%)	82/55	53/30	53/34			47/43	49/36	112/78	56/71
Tensile MD/CD (N/cm)	4.7/7.9	3.8/8.4	7./12			7./8.8	9./16	7./2.8	17/3
Elongation MD/CD (%)	41/36	37/33	39/41			34/35	34/29	56/29	50/44
Fiber Surface Stability:									
Belt side (g)	0.0061	0.0143	0.0148	0.0385	0.0405	0.0048	0.0122	0.0244	0.00754
Top side (g)	0.0344	0.0724	0.0236	0.0208	0.0513	0.0129	0.0045	0.0667	0.0043
Wiping Performance (%):									
Home environment	110	130	117/150		108	100/130		100	
Light Industrial	122	117	110/120		83	107/86		100	
Heavy Industrial	107	107	100/90		100	107/80		100	

Table 2

Example	Comparison 5	8	10	11	12	13
Spun condition (% polymer/degrees C)	17/190	17/190	17/190	17/190	17/190	17/190
Needle (density/penetration upper/lower):						
Density (needles/cm^2)		60	100	100	150	225
Penetration (upper/lower) (mm)		10./5	10.0/5	5.0/5	5.0/5	5.0/5
Basis Weight (g/m^2)	54	51	51	51	51	51
Thickness (mm)	0.203	0.3	0.31	0.297	0.312	0.368
Thickness/BW (m^3/g)	3.80E-06	5.90E-06	6.10E-06	5.80E-06	6.10E-06	7.20E-06
Density (g/cm^3)	0.267	0.17	0.164	0.172	0.163	0.138
Void Fraction (%)	71.9	82.1	82.7	81.9	82.8	85.5
Grab Tenacity MD/CD (N/cm)	19/28	30/35	23/28	30/31	23/22	30/31
Grab Elongation MD/CD (%)	40/51	47/43	50/44	52/47	47/41.6	52/43.6
Tensile MD/CD (N/cm)	3.5/4.5	7/8.8	7/7.9	7.7/8.8	7.5/6.6	6.6/8.9
Elongation MD/CD (%)	9./13	34/35	32/35	29/32	27/33	30.2/34
Fiber Surface Stability:						
Belt side (g)	0.554	0.0048	0.0194	0.011	0.079	0.016
Top side (g)	0.156	0.0129	0.0108	0.017	0.023	0.016
Wiping vs.Swiffer:						
Home environment	76	109/130	93	138	110	150
Light Industrial	82	122/86	126	114	114	118
Heavy Industrial	100	98/80	93	100	106	107
Surface Area (m^2/g)	15.3	11.8	9.5	10.8	8.4	9.7

EXAMPLES 14-17

Flash spun unbonded batts were obtained by flash spinning high density polyethylene at various concentrations in a blend of pentane and cyclopentane spin agent at various temperatures by a process as described in Brethauer. The batts were lightly consolidated using a nip roll. The spinning conditions (percent polymer in spin agent and spinning temperature) and properties measured for each of these batts are listed as Comparative Examples 1-6 in Table 1.

The batts were then hydroentangled using high pressure water on each of the top and bottom surfaces. The number of jets, jet type, jet pressure and apertured member were varied to achieve various fabric strength, fiber surface stability and thickness. The properties of these hydroentangled batts, or nonwoven fabrics, are listed as Examples 14-17 in Table 3. In each case, the batt was supported on a first apertured member and hydroentangled by making several passes under high pressure water jets with the line running at 50 yards per minute. The batt was then turned over, placed on a second apertured member and again hydroentangled by making several passes under high pressure water jets with the line running at 50 yards per minute.

Table 3

Example	14	15	16	17
Spun condition (% polymer/degrees C)	17/200	17/200	17/200	17/200
Water jet pressure		Low Pressure	High Pressure	Low Pressure
Basis Weight (g/m^2)	47	58	58	58
Thickness (mm)	0.292	0.318	0.356	0.356
Thickness/BW (m^3/g)	6.20E-06	5.50E-06	6.10E-06	6.10E-06
Density (g/cm^3)				
Void Fraction (%)				
Grab Tenacity MD/CD (N/cm)	42	58	47	42
Grab Elongation MD/CD (%)	46	34	36	44
Tensile MD/CD (N/cm)	25.4	12.2	19.2	14
Elongation MD/CD (%)	24	40	37	37
Fiber Surface Stability:				
Belt side (g)		0.018	0.006	0.003
Top side (g)		0.013	0.01	0.003
Wiping vs.Swiffer:				
Home environment		80	130	110
Light Industrial				
Heavy Industrial		95	96	91
Surface Area (m^2/g)	8.6	8	6.3	7.1

Example 14

During the first pass of hydroentangling, the batt was supported on a first apertured member of a 75 mesh woven wire. Four jets were used. During the second pass of hydroentangling, the batt was supported on a second apertured member of a perforated plate having a clover pattern with a 20 mesh sub screen. Three jets were used. The jet hole diameters, number of holes per inch per jet, and the jet operating pressures are listed below in Table 4.

Table 4

Jet	Hole diameter (mils)	Holes per inch	Pressure (psi)
First Pass			
1	4	80	500
2	5	40	1000
3	5	40	1500
4	5	40	1500
Second Pass			
1	4	80	300
2	5	40	500
3	5	40	1000

Example 15

During the first pass of hydroentangling, the batt was supported on a first apertured member of a 75 mesh woven wire. Four jets were used. During the second pass of hydroentangling, the batt was supported on a second apertured member of an 8 mesh woven wire. Four jets were used. The jet parameters are listed in Table 5.

Table 5

Jet	Hole diameter (mils)	Holes per inch	Pressure (psi)
First Pass			
1	4	80	500
2	5	40	1000
3	5	40	1500
4	5	40	1500
Second Pass			
1	4	80	500
2	5	40	800
3	5	40	1000
4	5	40	1000

Example 16

During the first pass of hydroentangling, the batt was supported on a first apertured member of a 75 mesh woven wire. Four jets were used. During the second pass of hydroentangling, the batt was supported on a second apertured member of an 13 mesh woven wire. Eight jets were used. The jet parameters are listed in Table 6.

Table 6

Jet	Hole diameter (mils)	Holes per inch	Pressure (psi)
First Pass			
1	4	80	500
2	5	40	1000
3	5	40	1500
4	5	40	1500
Second Pass			
1	4	80	300
2	4	80	500
3	5	40	800
4	5	40	1000
5	5	40	1200
6	5	40	1500
7	5	40	1700
8	5	40	1800

Example 17

During the first pass of hydroentangling, the batt was supported on a first apertured member of a 75 mesh woven wire. Eight jets were used. During the second pass of hydroentangling, the batt was supported on a second apertured member of an 8 mesh woven wire. Eight jets were used. The jet parameters are listed in Table 7.

Table 7

Jet	Hole diameter (mils)	Holes per inch	Pressure (psi)
First Pass			
1	4	80	300
2	5	40	500
3	5	40	800
4	5	40	1000
5	5	40	1200
6	5	40	1500
7	5	40	1800
8	5	40	1800
Second Pass			
1	4	80	300
2	4	80	500
3	5	40	800
4	5	40	1000
5	5	40	1200
6	5	40	1500
7	5	40	1700
8	5	40	1800

WHAT IS CLAIMED IS:

1. A bulky fibrous fabric comprising a batt of fibers each fiber having a ribbon-shaped cross-section, the batt having a surface area of at least 2 m^2/g and a thickness/basis weight ratio of at least 0.005 $mm/g/m^2$ (7 $mil/oz/yd^2$).

2. A bulky fibrous fabric made by a process comprising:

a) obtaining an unbonded, consolidated batt of fibers wherein each fiber has a ribbon-shaped cross-section; and

b) needling said batt to obtain the bulky fibrous fabric having a surface area of at least 2 m^2/g and a thickness/basis weight ratio of at least 0.005 $mm/g/m^2$ (7 $mil/oz/yd^2$).

3. The bulky fibrous fabric of claim 2 wherein the batt is made from flash-spun plexifilamentary film-fibril web.

4. The bulky fibrous fabric of claim 2 or claim 3 wherein the needling is performed by hydroentangling.

5. The bulky fibrous fabric of claim 2 or claim 3 wherein the needling is performed by needlepunching.

6. The bulky fibrous fabric of claim 1 wherein the bulky fibrous fabric is a nonwoven fabric and the fibers are polyolefin.

7. The bulky fibrous fabric of claim 1 wherein the bulky fibrous fabric is a nonwoven fabric and the fibers are polyethylene.

8. The bulky fibrous fabric of claim 6 wherein the surface area is between 2 and 30 m^2/g and the thickness/basis weight ratio is between .005 and .0075 $mm/g/m^2$.

9. A bulky nonwoven fabric made by a process comprising:

a) obtaining an unbonded, consolidated flash-spun batt;

b) needlepunching said flash-spun batt to obtain the bulky nonwoven fabric having a surface area of at least 2 m^2/g, a thickness/basis weight ratio of at least 0.005 $mm/g/m^2$, a thickness of at least 0.20 mm and a basis weight of between 37 and 78 g/m^2.

10. A dry wipe useful for cleaning and dusting made from the bulky nonwoven fabric according to any of the preceding claims.

INTERNATIONAL SEARCH REPORT

PCT/US 02/15235

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D04H3/16 D01D5/11 D04H1/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04H D01D A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 94 11557 A (DU PONT) 26 May 1994 (1994-05-26) page 5, line 12 -page 6, line 7	1-10
X	US 4 910 075 A (LEE CHI-CHANG ET AL) 20 March 1990 (1990-03-20) column 2, line 27 -column 3, line 33	1-10
X	US 3 169 899 A (WALTER STEUBER) 16 February 1965 (1965-02-16) column 2, line 42 -column 14, line 58	1-3,5-10
A	US 4 704 321 A1 (ZAFIROGLU DIMITRI P) 3 November 1987 (1987-11-03) column 2, line 10 -column 4, line 46	1-3,6-10

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 September 2002	20/09/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	V Beurden-Hopkins, S

INTERNATIONAL SEARCH REPORT

Information on patent family members

PCT/US 02/15235

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