A soft drapable nonwoven material having good bi-directional strength-stretch characteristics which is especially suitable for a sanitary napkin wrapper is described. The material comprises a web of staple length fibers such as a carded web having a predominant direction of fiber orientation and a pattern of adhesive lines serving to unite the fibers together into a coherent nonwoven material. The adhesive lines are uniformly spaced in the direction of fiber orientation and extend continuously across the web generally perpendicular to the direction of predominant fiber orientation. The adhesive lines are also disposed uniformly over the web in a regularly repeating oscillating pattern with the crests pointed in the direction of fiber orientation. The pattern period, line amplitude, and line spacing are carefully selected to insure that as the web is strained in the direction perpendicular to that of original fiber orientation web rupture is avoided over elongations of at least about 25 percent.

17 Claims, 2 Drawing Figures
SOFT, DRAPEABLE NONWOVEN MATERIAL

DESCRIPTION OF THE INVENTION

The present invention relates to the preparation of soft, drapable, nonwoven materials having desirable strength and stretch characteristics. More particularly, it relates to nonwoven materials prepared from webs of staple length fibers which have a predominant direction of fiber orientation. The invention is especially concerned with the preparation of adhesively bonded carded webs with good bi-directional strength and stretch characteristics rendering them suitable for use as sanitary napkin covers and the like.

In recent years, many patents have issued directed to the adhesive bonding of nonwoven webs of staple length fibers such as those prepared by carding, garnetting or drafting. Examples of such patents include the following: U.S. Pat. Nos. 2,039,312; 2,545,952; 2,705,687; 3,009,822; and 3,484,330. Since such webs have a predominant direction of fiber orientation, the problem faced in bonding the webs to impart coherency for use in fabric-like applications has been to achieve sufficient strength and stretch in the direction perpendicular to that of the predominant fiber orientation while all at the same time not giving rise to an undesirable web harshness or stiffness.

It is recognized that discontinuous bonding techniques are generally useful in obtaining soft, drappable webs and fabric. Adhesive bonding patterns suggested include localized spot bonds of various shapes, wavy or straight lines of adhesive and diamond and herringbone patterns to mention a few. However, many of the suggested approaches are not completely satisfactory in achieving good bi-directional strength and stretch characteristics in combination with web softness and drapability. In addition, with adhesive patterns containing short discontinuous lines, difficulties in accomplishing uniform printing of the adhesive onto the web have been noted, particularly when an intaglio method is used and high printing speeds employed. With intaglio methods, difficulties have been encountered in achieving rapid and uniform adhesive transfer from the print roll depressions to the web. As a result, the pattern of adhesive printed on the web is not sharply defined, and this can detract from the web’s softness, drapability, and strength characteristics.

Accordingly, it is a principal object of the present invention to provide a soft, drapable adhesively bonded nonwoven material of staple length fibers having a predominant direction of fiber orientation which possesses good strength and stretch characteristics in both the direction of orientation and the direction perpendicular thereto.

A closely related object is to provide a material having the above-recited characteristics wherein the adhesive can be rapidly printed onto the unbonded web by intaglio techniques to give a sharply defined adhesive print pattern.

A further object resides in providing absorbent sanitary pads having, as a cover, a web possessing the characteristics recited in the foregoing objects. A closely related object is to provide a sanitary pad which is flushable and yet possess good initial strength.

Yet other objects and advantages will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIG. 1 is a fragmentary plan view illustrating an embodiment of a bonded web prepared in accordance with the present invention and
FIG. 2 illustrates a sanitary napkin having the web illustrated in FIG. 1 as a cover therefore.

While the invention is susceptible of various modifications and alternative constructions, there is shown in the drawings and will herein be described in detail the preferred embodiments. It is to be understood, however, that it is not intended to limit the invention to the specific forms disclosed. On the contrary, it is intended to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Briefly stated, nonwoven materials according to the present invention are prepared from webs containing customary staple length textile fibers having a predominant direction of orientation. A distinctive pattern of adhesive lines unites the staple length fibers together into a coherent nonwoven material. The adhesive lines are closely spaced together in the direction of predominant fiber orientation and run continuously across the web in a direction perpendicular thereto. In addition, the continuous adhesive lines are disposed uniformly over the web in a regularly repeating oscillating pattern with particularly defined characteristics with respect to the relationship between the period of oscillation, the adhesive line amplitude, and the spacing between adjacent adhesive lines.

Turning now to the drawings, FIG. 1 illustrates a nonwoven material constructed in accordance with an embodiment of the present invention. The material contains a web of generally staple length fibers having a predominant direction of fiber orientation indicated by the arrow O. Union of the web of staple length fibers into a coherent material is achieved by means of a pattern of adhesive lines, the adhesive of which, it will be understood, extends substantially through the thickness of the web. As illustrated, the adhesive lines have a width w, and are uniformly spaced apart in the direction of fiber orientation a distance s. The individual adhesive lines extend continuously across the web of staple length fibers in the direction indicated by the arrow P which is substantially perpendicular to the direction of fiber orientation O. Additionally, it can be seen that the lines of adhesive are disposed uniformly over said web in a regularly repeating oscillating pattern of a generally nested herringbone configuration with the crests 16 of the lines pointed in the direction of fiber orientation O. The adhesive lines making up the oscillating pattern have an amplitude a with a period of oscillation p.

With respect to the FIG. 1 embodiment of the present invention, it is important that the dimensions of the adhesive lines, their spacing s, and the characteristics of the adhesive pattern with respect to amplitude, oscillation period and line spacing be carefully selected. Since an important objective of the present invention lies in providing a soft, drappable nonwoven material, web bonding is achieved with a small quantity of adhesive, generally on the order of about 5–30 percent, based on the web weight, and preferably only 5–15 percent. To this end, the selection of the width w of the adhesive lines and their spacing s is important.
Regarding the spacing $s$ between adjacent continuous lines of adhesive, such should be less than the average fiber length in order to insure that the web fibers are attached between at least two adjacent lines of adhesive to provide web coherency. It is preferred that the spacing be substantially less than the average fiber length to provide for attachment of fibers between many adhesive lines. However, the spacing should be not so close as to require excessive quantities of adhesive which can adversely affect softness and drapability of the bonded material. With webs such as those prepared by carding staple textile fibers having a length of about one-half inch to 2.5 inches, line spacings of about 0.02–0.8 inch and preferably 0.04–0.4 inch are useful.

It is preferred that the adhesive line width $w$ be as small as possible and generally less than about one-half of the line spacing $s$. As previously mentioned a desirable adhesive application technique is of the intaglio type wherein adhesive dispersed in depressions on a print roll is directly transferred to the web. With such, the adhesive line width $w$ at a minimum will correspond to that minimum width on the adhesive print roll necessary to drain adhesive from the depressions on contact with the web. Upon transfer, however, some adhesive spreading can occur. Adhesive line widths $w$ of about 0.01–0.3 inch and preferably 0.02–0.2 inch are useful.

To permit functionally useful web elongation in the direction perpendicular to that of predominant orientation without accompanying material rupture and adhesive disruption, it is important that the amplitude $a$ of the adhesive lines be coordinated with the period of oscillation $p$. To achieve useful elongations on the order of about 25 percent or more, an amplitude to period ratio ($a/p$) of at least about 0.5 is necessary. An amplitude to period ratio of about 0.8–1.2 affords at least about 40 percent elongation and is preferred. At ratios of less than about 0.5, insufficient elongation without accompanying rupture is present to utilize the bonded materials in applications such as sanitary napkin wrappers. Ratios in excess of about 2 are generally not particularly useful due to the resulting presence of excessive quantities of adhesive. The actual period $p$ of oscillation is of lesser importance than the relationship between the line amplitude and the line period. Periods, $p$, of about $\frac{1}{4}$–1 inch across the perpendicular direction P are generally useful.

Still referring to FIG. 1, the illustrated oscillating nested configuration of the adhesive pattern is also important in achieving a desirable combination of stretch and strength in the indicated direction P. Regarding this aspect of the present invention, the adhesive line amplitude, $a$, and the line spacing, $s$, are coordinated such that adjacent continuous lines of adhesive are placed in a nested configuration such as illustrated in FIG. 1. With adhesive line nesting, no continuous straight lines uninterrupted by adhesive exist across the perpendicular direction of the web. Thus, web failure in this direction must be propagated along a tortuous path and this appears to contribute to the desirable strength characteristics of the web in the direction perpendicular to that of orientation. In order to achieve nesting with the above indicated useful amplitude to period ratios, i.e., 0.5–2, the amplitude $a$ is at least about 1.5–4 times the line spacing $s$ with increasing minimum values within the recited range being substantially linearly associated with increasing amplitude to period ratios.

So as not to result in the presence of excessively large quantities of adhesive and as to place a given line of adhesive in nested configuration with only those two next adjacent lines, the line amplitude $a$ is preferably less than about 4–9.5 times the line spacing $s$ with increasing maximum values within this recited range being again substantially linearly associated with larger amplitude to period ratios within the indicated range of 0.5–2. With amplitude to periods ratios within the preferred range of 0.8–1.2, it is preferred to employ a line amplitude of about 3–6 times the line spacing.

The use of the adhesive pattern having the particular characteristics described herein permits the preparation of nonwoven materials from oriented staple length fibers which fully satisfy the aims and objectives of the present invention. The necessary quantity of adhesive is low and thus the materials are soft and drapable. The close spacing of the lines in the direction of predominant fiber orientation (normally the lengthwise direction of the unbonded web) and the fact that the lines are continuous across the width of the material assures that substantially all of the fibers will be adhesive-ly attached together in the oriented direction between at least two adjacent adhesive lines. Thus, as the material is strained in the direction of orientation, a large number of fibers are available for simultaneous involvement in a load bearing capacity. In turn, the material exhibits a particularly high strength in the direction of orientation over elongations commensurate with the extensibility of the fibers employed. Also, the fact that a pattern with continuous adhesive lines across the web width is used permits the achievement of sharply defined adhesively printed areas which contribute to material softness and drapability.

The regularly repeating oscillating pattern of adhesive lines wherein the period, line amplitude, and line spacing are coordinated in the manner hereinafter above-discussed appears to be instrumental in achieving the indicated desirable strength and stretch characteristics in the direction perpendicular to that of original fiber orientation. As the web is strained in the direction perpendicular to that of orientation, fiber realignment toward the direction of the applied strain appears to occur as elongation proceeds while the adhesive lines remain substantially in tact. Thus the fibers can support the applied strain and accompanying material rupture is avoided.

As concerns the principal aspects of the present invention, the type of staple length textile fiber employed in preparing useful webs is not particularly important so long as adhesive bonding in the manner indicated can be achieved. Cellulosic fibers such as rayon are desirably used for the preparation of sanitary napkin wrappers and the like. However, other fibers such as those prepared from thermoplastic polymers or for that matter naturally occurring necessary quantities of fibers can also be used.

As previously indicated webs prepared from fibers having lengths on the order of about $\frac{1}{2}$–2.5 inches can be easily prepared by known techniques such as carding, garnetting, and drafting. The fibers in the webs so prepared have a predominant direction of fiber orienta-
tion. Thus, achieving the advantages of the present invention with respect to good strength and stretch characteristics in the direction opposed to orientation is generally applicable to such webs.

However, it appears that the present invention is particularly suitable to webs which, while having a predominant direction of fiber orientation, nevertheless have some fibers disposed away from the predominant orientation direction. Carded webs are representative of this type, the webs generally containing only about 50–75 percent of substantially parallelly aligned fibers. The nested configuration of the adhesive lines in the presently illustrated pattern in combination with the close spacing of the lines permits the fibers disposed away from the direction of predominant orientation to be efficiently utilized in a load bearing capacity when the web is strained in the perpendicular direction. In addition, since the adhesive lines extend continuously across the perpendicular direction, a strain applied in the direction of orientation also serves to bring such fibers into closer alignment with the predominantly oriented fibers thus permitting them to participate in a load carrying capacity when the web is strained in the direction of predominant orientation.

As concerns the present invention, the particular type of adhesive used to effect bonding is not particularly important. A variety of adhesives such as acrylics, polyvinyl alcohols, plastisols, etc. can be employed. Adhesive selection can be influenced by the application technique used, and particularly by the viscosity requirements of the desired technique. Adhesive selection can also be important when it is desired that the bonded material be dispersible in water such as is required for flushable sanitary napkins.

Turning now to FIG. 2, there is illustrated an embodiment of a sanitary napkin 18 prepared in accordance with the present invention. The napkin 18 contains an inner core of absorbent material 20 such as cellulosic fluff or wadding and a cover 22 enclosing the inner core and providing end tabs 24 for the attachment of a belt or the like. In accordance with the present invention, the cover 22 is a bonded nonwoven material such as illustrated in FIG. 1 wherein the direction of predominant fiber orientation is in alignment with the length of the napkin and the continuous adhesive lines disposed in the illustrated pattern extend in the widthwise direction and around the inner core.

The illustrated cover material having the previously discussed desirable bi-directional strength characteristics can be readily wrapped, without rupture, around the inner core and adhesively sealed to enclose the core using conventional automatic sanitary napkin manufacturing equipment. Thus, the use of the nonwoven material illustrated herein is particularly suitable for sanitary napkin covers. When so employed, carded webs prepared from rayon fibers having a basis weight (before adhesive application) of up to about 1 oz./yd.² and preferably about 0.3–0.6 oz./yd.² are useful.

In addition, the use of sanitary napkin cover materials prepared in accordance with the present invention is advantageous where napkin flushability is desired. It is recognized that the adhesive used in bonding the cover for flushable napkin applications must be water soluble so that the cover can disintegrate when subjected to gentle agitation in water. Cold water soluble adhesives such as polyvinyl alcohols prepared from partially saponified polyvinyl acetate have been suggested. The problem is to achieve adequate disintegration after the use in combination with sufficient initial strength so that the cover does not also disintegrate when subjected to menstrual fluids in use and also sufficient wrapper flexibility for comfort to the wearer. U.S. Pat. No. 3,561,447 suggests the use of a combination of adhesives. Furthermore, it has been noted that with some conventional bonding patterns, the use of a polyvinyl alcohol adhesive alone without suitable plasticizers or the like can result in a somewhat stiff wrapper. The use of plasticizers can be undesirable since they tend to weaken the adhesive thus further contributing to the cover's lack of strength. However, it has been found that with webs bonded with the present pattern, a polyvinyl alcohol adhesive can be used, and that the webs so prepared are soft and drapable and have sufficient initial strength to permit their successful use as flushable napkin wrappers.

The explanation for this unexpected utility can be found in the configuration of the pattern employed. As has been mentioned, the use of the pattern results in improved strength characteristics which are manifested in imparting the necessary strength to the web. The fact that the normally brittle polyvinyl alcohol adhesive does not lead to an undesirable stiffness appears to be principally attributable to the oscillating pattern employed which provides a desirable elasticity.

To further illustrate the present invention, a web (14 grms./yd²) of rayon fibers having an average fiber length of about 1-9/16 inches (range of 1½ inches to 1¾ inches) was formed by carding and bonded with an adhesive pattern such as illustrated in FIG. 1 having the following characteristics:

| s | 0.10 inch |
| a | 0.45 inch |
| w | 0.04 inch |
| p | 0.50 inch |

About 60 percent of the fibers were substantially parallelly aligned in the machine direction. Adhesive printing onto the web was accomplished with an intaglio print roll, and the web was wetted (250 percent moisture) before printing. The grooves on the intaglio print roll were about 0.006 inch deep, the groove width was 0.03 inch, and the groove amplitude and spacing were 0.40 inch and 0.10 inch, respectively. The groove crests were slightly rounded to aid in adhesive transfer to the web and the grooves contained screen lines (0.002 inch wide, 10/period) to aid in doctor blade performance. A polyvinyl alcohol adhesive (89 percent hydrolyzed polyvinyl acetate — 4 percent aqueous sol. visc. 22 cps. — PVA 523 "AIRCOC") was used and applied to the web at a viscosity of 400 cps. The bonded web contained about 1 grm/yd² of adhesive. Web drying was accomplished at 320°F. The web so prepared had the following characteristics: Instron — 1 × 2 inch samples — 2 cm/min. (MD) and 5 cm/min. (CD)

<table>
<thead>
<tr>
<th>Machine Direction</th>
<th>Tensile strength (inch-lbs.)</th>
<th>Elongation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>5.5</td>
<td>0.31</td>
</tr>
</tbody>
</table>

The bonded material prepared as illustrated above is very suitable as a sanitary napkin cover. With this cover
material, sanitary napkins can be commercially prepared using conventional equipment without rupture of the cover during automatic wrapping thereof around the absorbent inner core.

I claim as my invention:

1. A soft, drapable nonwoven material having good bi-directional strength-stretch characteristics comprising, in combination, a web of staple length fibers having a predominant direction of fiber orientation and a pattern of adhesive lines serving to unite the fibers together into a coherent nonwoven material with said adhesive being about 5–30 percent of the web weight, said lines of adhesive being uniformly spaced in the direction of fiber orientation less than an average fiber length apart, having a width of less than about one-half the line spacing, and extending continuously across said web generally perpendicular to the direction of predominant fiber orientation thus simultaneously involving a substantial number of fibers in a load bearing capacity when the web is strained in the direction of orientation, said lines of adhesive being further disposed uniformly over said web in a regularly repeating oscillating pattern with the crests thereof pointed in the direction of predominant fiber orientation and characterized by the combination of (1) a period of about \( \frac{1}{4} – 1 \) inch, (2) a line amplitude of at least about 1.5–4 times the line spacing to place said lines in nested configuration, and (3) an amplitude to period ratio of about 0.5–2 so that, as the web is strained in the direction perpendicular to that of original orientation, fiber realignment occurs without accompanying adhesive disruption thus permitting the fibers to bear the so applied strain over elongations of at least about 25 percent.

2. The material of claim 1 wherein the fibers have a length of about \( \frac{1}{2} – 2.5 \) inches, the adhesive line spacing is about 0.02 – 0.8 inch, and the adhesive line width is about 0.01 – 0.3 inch.

3. The material of claim 1 wherein the fibers have a length of about \( \frac{1}{2} – 2.5 \) inches, the adhesive line spacing is about 0.04 – 0.4 inch, and the adhesive line width is about 0.02 – 0.2 inch.

4. The material of claim 1 wherein the adhesive line amplitude is less than about 4–9.5 times the adhesive line spacing.

5. The material of claim 4 wherein the amplitude to period ratio is about 0.8–1.2 and the amplitude is about 3–6 times the line spacing.

6. The material of claim 5 wherein the fibers have a length of about \( \frac{1}{2} – 2.5 \) inches, the adhesive line spacing is about 0.02 – 0.8 inch, and the adhesive line width is about 0.01 – 0.3 inch.

7. The material of claim 6 wherein the web of staple length fibers has a basis weight of about 0.3 – 0.6 oz./yd.\(^2\) and wherein the adhesive is about 5–15 percent of the web weight.

8. The material of claim 7 wherein the fibers have a length of about \( \frac{1}{4} – 2.5 \) inches, the adhesive line spacing is about 0.04 – 0.4 inch, and the adhesive line width is about 0.02 – 0.2 inch.

9. The material of claim 8 wherein the web of staple length fibers is a carded web.

10. A sanitary napkin containing an elongated absorbent inner core and as a cover therefore a nonwoven material comprising, in combination, (I) a web having a basis weight of up to about 1 oz./yd.\(^2\) of staple length fibers with a predominant direction of fiber orientation in the lengthwise direction of the inner core and (II) a pattern of adhesive lines serving to unite the fibers together into a coherent material with said adhesive being about 5–30 percent of the web weight, said lines of adhesive being uniformly spaced in the direction of fiber orientation less than an average fiber length apart, having a width of less than about one-half the line spacing, and extending continuously across said web generally perpendicular to the direction of predominant fiber orientation, said lines of adhesive being further disposed uniformly over said web in a regularly repeating oscillating pattern with the crests thereof pointed in the direction of predominant fiber orientation and characterized by the combination of (1) a period of about \( \frac{1}{4} – 1 \) inch, (2) a line amplitude of at least about 1.5–4 times the line spacing to place said lines in nested configuration, and (3) an amplitude to period ratio of about 0.5–2.

11. The sanitary napkin of claim 10 wherein the adhesive line amplitude is less than about 4–9.5 times the adhesive line spacing.

12. The sanitary napkin of claim 11 wherein the amplitude to period ratio is about 0.8–1.2 and the amplitude is about 3–6 times the line spacing.

13. The sanitary napkin of claim 12 wherein the fibers have a length of about \( \frac{1}{2} – 2.5 \) inches, the adhesive line spacing is about 0.02 – 0.8 inch, and the adhesive line width is about 0.01 – 0.3 inch.

14. The sanitary napkin of claim 13 wherein the fibers have a length of about \( \frac{1}{2} – 2.5 \) inches, the adhesive line spacing is about 0.04 – 0.4 inch, and the adhesive line width is about 0.02 – 0.2 inch.

15. The sanitary napkin of claim 14 wherein the web of staple length fibers is a carded web having a basis weight of about 0.3 – 0.6 oz./yd.\(^2\).

16. The sanitary napkin of claim 15 wherein the adhesive is about 5–15 percent of the web weight.

17. The sanitary napkin of claim 16 wherein the adhesive is polyvinyl alcohol.

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