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**ABSORBENT ARTICLE HAVING IMPROVED
ADHESIVE SYSTEM TO PROVIDE
FLEXIBILITY AND BREATHABILITY**

FIELD OF THE INVENTION

The present invention relates to absorbent articles such as sanitary napkins, panty liners, adult incontinence devices, bandages, and the like. Still more particularly, the present invention concerns absorbent articles such as sanitary napkins and the like that have adhesive regions for securement to a wearer's undergarments.

BACKGROUND OF THE INVENTION

All manner and variety of absorbent articles configured for the absorption of body fluids such as blood, menses, urine, and feces are, of course, well known. Absorbent articles are typically comprised of a number of layers of material. These generally include, from top to bottom, a liquid pervious layer, an absorbent layer, and a liquid impervious layer. Additional layers may also be interposed between any of these layers. Such additional layers may serve various different purposes.

Absorbent articles, in particular absorbent articles such as feminine hygiene articles (sanitary napkins, panty liners, etc.) which are intended to be worn in conjunction with a garment, are frequently provided with an adhesive securement system to maintain proper positioning of the absorbent article under in-use conditions.

While such adhesive systems have achieved a level of success, the expansive regions of adhesive coatings tend to occlude pores and permeable surfaces in breathable substrates. Other less-expansive adhesive systems using intermittent regions of adhesive typically compromise adhesion for the sake of breathability or, conversely, compromise breathability for adhesion.

SUMMARY OF THE INVENTION

An absorbent article, such as a diaper, a sanitary napkin, a panty liner, an adult incontinence device, a bandage, or the like is provided which has: (a) a liquid pervious topsheet defining a body-facing side of the absorbent article; (b) a liquid impervious backsheet joined to the topsheet and defining a garment-facing side of the absorbent article; (c) an absorbent layer being positioned between the topsheet and the backsheet; and (d) an adhesive system located on the backsheet. The adhesive system comprises a



plurality of three-dimensional protrusions which are deformable into a substantially two-dimensional configuration and an interconnected network of adhesive surrounding the protrusions which is protected from inadvertent contact with external surfaces until the three-dimensional protrusions are deformed into a substantially two-dimensional configuration. The absorbent article preferably includes a plurality of flaps which may themselves preferably include an adhesive system, and the backsheet of the absorbent article is preferably breathable.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims which particularly point out and distinctly claim the present invention, it is believed that the present invention will be better understood from the following description of preferred embodiments, taken in conjunction with the accompanying drawings, in which like reference numerals identify identical elements and wherein:

Figure 1 is a top plan view of a preferred sanitary napkin embodiment of the present invention;

Figure 2 is a lateral cross-sectional view taken along line 2-2 of the sanitary napkin shown in Figure 1;

Figure 3 is a lateral cross-sectional view taken along line 3-3 of Figure 1 through the center portion of one of the flaps;

Figure 4 is a top plan view of the topsheet of a thicker sanitary napkin showing a preferred bonding pattern thereon;

Figure 5 is a bottom plan view of a preferred embodiment of an adhesive system on a sanitary napkin according to the present invention;

Figure 6 is a bottom plan view of another embodiment of an adhesive system on a sanitary napkin according to the present invention;

Figure 7 is an enlarged view of an adhesive system in accordance with the present invention; and

Figure 8 is a further enlarged partial view of the adhesive system of Figure 7.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to adhesive systems for absorbent articles such as sanitary napkins, panty liners, incontinence devices, diapers, bandages, and the like.

Absorbent Article Construction:

A preferred embodiment of a sanitary napkin 20 of the present invention is shown in FIG. 1. As shown in FIG. 1, the sanitary napkin 20 preferably comprises an absorbent means (or "main body portion") 22, and two optional flaps 24. The sanitary napkin 20 has two surfaces, a body-facing surface or "body surface" 20A and a garment surface 20B. The sanitary napkin 20 is shown in FIG. 1 as viewed from its body surface 20A. The body surface 20A is intended to be worn adjacent to the wearer's body. The garment surface 20B is intended to be placed adjacent to the wearer's undergarments when the sanitary napkin 20 is worn.

The sanitary napkin 20 has two centerlines, a principal longitudinal centerline L and a principal transverse centerline T. The term "longitudinal", as used herein, refers to a line, axis or direction in the plane of the sanitary napkin 20 that is generally aligned with (e.g., approximately parallel to) a vertical plane which bisects a standing wearer into left and right body halves when the sanitary napkin 20 is worn. The terms "transverse" or "lateral" used herein, are interchangeable, and refer to a line, axis or direction which lies within the plane of the sanitary napkin 20 that is generally perpendicular to the longitudinal direction.

FIG. 1 shows that the main body portion 22 of the sanitary napkin 20 comprises the portion of the sanitary napkin without the flaps 24. The main body portion 22 has two spaced apart longitudinal edges 26, two spaced apart transverse or end edges (or "ends") 28, which together form the periphery 30 of the main body portion. The main body portion 22 also has two end regions, which are designated first end region 32 and second end region 34. A central region 36 is disposed between the end regions 32 and 34. The end regions 32 and 34 extend outwardly in the longitudinal direction from the edges of the central region 36 about 1/8 to about 1/3 of the length of the main body portion. A detailed description of the characteristics of a central region and two end regions for a sanitary napkin is contained in U.S. Patent 4,690,680 issued to Higgins on September 1, 1987. The sanitary napkin 20 has a longitudinal central region 16 disposed along the length of at least a portion of the principal longitudinal centerline L, and longitudinal side regions 18 transversely outboard of the longitudinal central region 16.

The main body portion 22 of the sanitary napkin 20 can be of any thickness, including relatively thick, intermediate thickness, relatively thin, or even very thin (or "ultra thin"). An "ultra-thin" sanitary napkin 20 as described in U.S. Patents 4,950,264 and 5,009,653 issued to Osborn preferably has a caliper of less than about 3 millimeters. The embodiment of the sanitary napkin 20 shown in FIGS. 1-3 of the drawings is intended to be an example of an ultra-thin sanitary napkin. The main body portion 22 of the

sanitary napkin 20 may also be relatively flexible, so that it is comfortable for the wearer. It should, however, be understood that the sanitary napkins shown are merely two examples of embodiments, and that the present invention is not limited to absorbent articles of the type or having the specific configurations shown in the drawings.

FIG. 2 shows the individual components of the main body portion 22 of the sanitary napkin 20 of the present invention. The main body portion 22 of the sanitary napkin preferably comprises at least four primary components. These include a liquid pervious topsheet 38, a liquid impervious backsheet 40, an absorbent core 42 positioned between the topsheet 38 and the backsheet 40, and at least one acquisition component 44. The acquisition component 44 may either be a separate component positioned between the topsheet 38 and the absorbent core 42, or it may comprise part of a composite topsheet or part of the absorbent core 42. The components of the sanitary napkin 20 may be comprised of any suitable materials that are capable of being bonded in the manner described herein.

The topsheet 38 is a liquid pervious component that permits liquids (e.g., menses and/or urine) to readily penetrate through its thickness. The topsheet 38 is preferably as compliant, soft feeling, and non-irritating to the wearer's skin as possible. A suitable topsheet 38 may be manufactured from a wide range of materials such as woven and nonwoven materials; polymeric materials such as apertured formed thermoplastic films, apertured plastic films, and hydroformed thermoplastic films; porous foams; reticulated foams; reticulated thermoplastic films; and thermoplastic scrims. Suitable woven and nonwoven materials can be comprised at least partially of natural fibers (e.g., wood or cotton fibers), synthetic fibers (e.g., polymeric fibers such as polyester, polypropylene, or polyethylene fibers) or from a combination of natural and synthetic fibers.

A preferred type of topsheet comprises an apertured formed film. Apertured formed films are preferred for the topsheet because they are pervious to body exudates and, if properly apertured, have a reduced tendency to allow liquids to pass back through and rewet the wearer's skin. Thus, the surface of the formed film which is in contact with the body remains dry, thereby reducing body soiling and creating a more comfortable feel for the wearer. Suitable formed films are described in U.S. Patent 3,929,135, entitled "Absorptive Structures Having Tapered Capillaries", which issued to Thompson on December 30, 1975; U.S. Patent 4,324,246 entitled "Disposable Absorbent Article Having A Stain Resistant Topsheet", which issued to Mullane, et al. on April 13, 1982; U.S. Patent 4,342,314 entitled "Resilient Plastic Web Exhibiting Fiber-Like Properties", which issued to Radel, et al. on August 3, 1982; U.S. Patent 4,463,045 entitled "Macroscopically

Expanded Three-Dimensional Plastic Web Exhibiting Non-Glossy Visible Surface and Cloth-Like Tactile Impression", which issued to Ahr et al. on July 31, 1984; U.S. Patent 4,637,819 entitled "Macroscopically Expanded Three-Dimensional Polymeric Web for Transmitting Both Dynamically Deposited and Statically Contacted Fluids From One Surface to the Other", which issued to Ouellette, et al. on January 20, 1987; U.S. Patent 4,780,352 entitled "Covering Structure For Absorbent Hygienic Sanitary Products, and an Absorbent Product Having Such A Covering", which issued to Palumbo on October 25, 1988; U.S. Patent 5,006,394 "Multilayer Polymeric Film" issued to Baird on April 9, 1991; and U.S. Patent Application Serial No. 08/442,935 entitled "Fluid Transport Webs Exhibiting Surface Energy Gradients" filed in the name of Ouellette, et al. on May 31, 1995 (PCT Publication WO 96/00548, published January 11, 1996).

The terms "apertures" and "apertured" may include holes and/or slits which create passageways through the film layer from one surface to the other. The apertures can all be of the same size and shape, or they may be of different sizes and shapes. The apertures may be localized or they may extend across the entire surface of the film 38. When the aperturing is localized, it may be in the form of a longitudinal central portion or strip which separates two longitudinal side portions of the film which are not apertured. In addition, the entire topsheet can be made from a film or the longitudinal central portion can be made from a film and the longitudinal side portions can be made from another material such as a fibrous nonwoven web.

The apertured film 38 can be made of a number of suitable materials. Suitable polymers from which to form the apertured film 38 include any material which can be formed into a film including, but not limited to, polyolefins and polyacrylates, as well as copolymers and blends thereof. Specific polymers include, but are not limited to, polyethylene (PE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE) and ethylene vinyl acetate (EVA).

Typically the apertured film 38 will have a thickness between about 0.025 and about 1.0 millimeters and a percent open area due to the aperturing of between about 10 and about 40% based upon the surface area of the apertured film 38. Percent open area is calculated by specifying a unit area, calculating the surface area of all open areas within the specified unit area, dividing this total open area by the total surface within the specific unit area and then multiplying the quotient by 100 to yield percent open area. The size and number of apertures can be varied depending upon the viscosity and other properties of the body fluid being transported through the apertured film 38.

In preferred embodiments of the present invention, the body surface of the topsheet 38 is hydrophilic so that liquids will be transferred through the topsheet more readily. This diminishes the likelihood that menstrual fluid will flow off the topsheet rather than flowing into and being absorbed by the absorbent core. The body surface of the topsheet 38 can be made hydrophilic by treating it with a surfactant. Suitable methods of treating a topsheet with a surfactant are described in U.S. Patent 4,950,254 issued to Osborn.

In a preferred embodiment, the topsheet 38 comprises an apertured formed film made in accordance with U.S. Patents 4,342,314 issued to Radel, et al. and 4,463,045 issued to Ahr, et al., which is marketed on sanitary napkins as the DRI-WEAVE topsheet by The Procter & Gamble Company of Cincinnati, OH. Such an apertured film is preferably obtained as product No. X-5652 from Tredegar Film Products of Terre Haute, IN. In this preferred embodiment, during manufacture the resin used to form the apertured film is preferably provided with a surfactant incorporated therein.

The acquisition component (or "acquisition layer") 44 lies beneath the topsheet 38. The terms "layer" or "web", as used herein, include but are not limited to single unfolded sheets, folded sheets, strips of material, loose or bonded fibers, multiple layers or laminates of material, or other combinations of such materials. These two terms are thus, not limited to single unfolded layers or sheets of material. The acquisition component 44 may provide void volume beneath the topsheet 38 to increase the ability of the sanitary napkin to draw liquids through the topsheet 38. In the preferred embodiment described herein, the acquisition component 44 preferably provides resiliency to lateral compressive forces so that the sanitary napkin 20 has improved resistance to bunching. The acquisition component 44 may have an effective average pore size that is equal to that of the topsheet 38, or less than that of the topsheet.

The acquisition component 44 should be liquid permeable. The acquisition component 44 is also preferably compliant, soft feeling, and non-irritating to the user's skin. The acquisition component 44 has a body-facing face (or side), and a garment-facing face. The acquisition component 44 may be of any suitable size and shape. In the embodiment shown in FIG. 1, the acquisition component 44 is in the shape of a race track with slightly concave side edges, as is the portion of the topsheet 38 that overlies the main body portion 22 of the sanitary napkin 20. The dimensions of the acquisition component 44, however, are preferably not as large as those of the topsheet 38. In other embodiments, such as in the case of thicker sanitary napkins, such as the one shown in FIG. 4, the acquisition component may be in the form of a piece of material that is smaller than the absorbent core 42.

The acquisition component 44 can be made from any materials suitable for the above purposes that are capable of having the topsheet 38 fused to them. The acquisition component 44 may, for example, be comprised of woven or nonwoven materials. The fibers or other components of these materials may be synthetic, or partially synthetic and partially natural. Suitable synthetic fibers include polyester, polypropylene, polyethylene, nylon, viscose rayon, or cellulose acetate fibers. Suitable natural fibers include cotton, cellulose, or other natural fibers. The acquisition component 44 may also be at least partially comprised of cross-linked cellulose fibers. The acquisition component 44, if nonwoven, can be made by a number of different processes. These include, but are not limited to: air laid, wet laid, meltblown, spunbonded, carded, thermally bonded, air-through bonded, powder bonded, latex bonded, solvent bonded, spunlaced, and combinations of the foregoing.

Suitable thermally bonded wet laid nonwoven webs (which may be referred to as "TBOWL" for brevity) are described in U.S. Patent 5,549,589 entitled "Fluid Distribution Member for Absorbent Articles Exhibiting High Suction and High Capacity" issued to Horney, et al. on August 27, 1996.

In the embodiment shown in the drawings, the acquisition component 44 preferably comprises a laminate of two materials. The uppermost layer of this laminate (or "secondary topsheet") 46 preferably comprises an 19 g/yd² (22.5 g/m²) spunbonded polypropylene nonwoven material referred to as product No. 065MLPV60U (or "P-9") obtained from Fiberweb, North America of Washougal, WA. The uppermost layer preferably has a void volume of about 11.2 cc/g measured at 689 dynes per square centimeter (0.01 psi.), and an average pore size, measured using the Laplace/Washburn equation for capillary tension of between about 60 and about 70 microns.

The underlying layer of the laminate (or "tertiary topsheet") 48 preferably comprises a multi-bonded air laid material that is thermally bonded using powder bonding and latex bonding. In a preferred embodiment, this multi-bonded air laid material comprises about 77% cellulose fibers, about 20% powder binder, and about 3% latex coating (1.5% sprayed on each side of the web) and has a basis weight of about 50 g/yd² (about 60 g/m²). (Unless otherwise stated, all percentages herein are by weight.) Such a multi-bonded air laid material is preferably obtained as product No. 90830X312 from Merfin Hygienic Products, Ltd. of Delta, British Columbia, Canada.

These two layers are preferably laminated together by depositing the multi-bonded air laid material on the spunbonded polypropylene nonwoven material. The spunbonded material is used as a process aid or carrier web in the process of forming this laminate.

The laminate preferably has a caliper of about 1.2 mm measured at a pressure of 68.9 Pascals, and a void volume of about 13.6 cc/g measured at 689 dynes per square centimeter. The acquisition component 44 is preferably hydrophilic. The acquisition component 44 may be more hydrophilic than the absorbent core, or it can have the same hydrophilicity as the absorbent core. If desired, the acquisition component 44 can be treated with a surface active agent to provide make it more hydrophilic. Preferably, it has the same hydrophilicity as the absorbent core.

In alternative embodiments, the spunbonded polypropylene nonwoven material may have a greater or a lower basis weight, or it may be replaced by an air laid tissue, a wet laid tissue, or any of the materials described above. If a wet laid tissue is used instead of a polypropylene nonwoven material, the orientation of the laminate is preferably reversed so that in the finished product, the multi-bonded air laid nonwoven material lies above the wet laid tissue layer. In the case of thicker sanitary napkins, any of the acquisition components described above can be used. Additionally, in one preferred thicker sanitary napkin embodiment, a low density latex bonded air laid material can be used as the entire acquisition component (that is, no tertiary topsheet is required). A low density latex bonded air laid material suitable for this purpose is a material having a basis weight of about 80 g/m² known as product No. FG413MHB, which is obtained from Walkisoft, USA of Mt. Holly, NC.

The topsheet 38 is generally described herein as being fused to the acquisition component 44. This has been done for simplicity of description. (It is easier to discuss one preferred embodiment than it is to simultaneously describe all possible embodiments.) The topsheet 38 may be fused to one or more other underlying components. In the broadest sense, the topsheet comprises a first component that is fused to an underlying second component. The second component may be a separate component. Alternatively, the second component could be part of another component, such as part of the topsheet, part of the core, or part of some other component. In still other alternative embodiments, the acquisition component 44 may be omitted entirely. In embodiments where the acquisition component 44 is an integral layer of the core 42 or omitted entirely, the topsheet 38 may be considered to be fused to part of the absorbent core 42. In embodiments without an acquisition component 44, the absorbent core 42 can be comprised of at least some types of fibers (preferably synthetic fibers) that the topsheet 38 can be fused to. A sufficient amount of these fibers are preferably located near the body-facing surface of the absorbent core 42 to facilitate the fusion. Alternatively, if the absorbent core (or other underlying component) comprises powder binder, the topsheet 38

can be fused to the powder binder in the absorbent core 42 (or such underlying component).

In the preferred embodiment shown in the drawings, the acquisition component 44 is preferably joined to the apertured film topsheet 38 by fusion bonding the faces of the apertured film 38 and acquisition component, laminate 44. These components are bonded across a region of their surfaces that forms a "bonded region" 50 on the body-facing side 20A of the sanitary napkin 20.

The topsheet 38 and the laminate 44 are preferably bonded at a plurality of discrete bonded areas (or "bonds") 52. (However, it is also within the scope of the present invention for one or more of the individual bonds 52 to contact each other so that they are not spaced apart and discrete.) In the embodiment shown in FIG. 1, the bonded areas 52 are preferably spaced apart and distributed over the body-facing side 20A of the sanitary napkin 20, with the exception of a portion thereof that defines an unbonded window 54 in a liquid receiving zone of the sanitary napkin.

The discrete bonded areas preferably comprise fusion bonds 52. The fusion can be accomplished by heat and/or pressure bonds, ultrasonic bonds, dynamic mechanical bonds, and the like. Pressure can be applied in any suitable manner, such as by moving the components to be bonded between counter-rotating rolls, placing the materials on an anvil and forcing a platen down on the materials, applying vacuum pressure, and the like. Suitable means that can be adapted for use in fusing the topsheet 38 to the acquisition component 44 are described in at least some of the following patents: U.S. Patent 4,430,148 Schaefer; U.S. Patent 4,515,595 Kievit, et al.; U.S. Patent 4,531,999 Persson, et al.; U.S. Patents 4,710,189 and 4,808,252 issued to Lash; U.S. Patent 4,823,783 Willhite, Jr., et al.; and U.S. Patents 4,854,984 and 4,919,756 issued to Ball, et al.; and in allowed U.S. Patent Application Serial No. 07/944,764 filed in the name of Cree, et al. on September 14, 1992, the parent application which published June 24, 1993 as PCT Publication No. WO 93/11725.

The fusion bonding preferably comprises a plurality of individual fusion bonds 52 that are arranged in a pattern. The bonds 52 can be arranged in many different patterns. Figures 1 and 4 show two particularly preferred bonding patterns. The individual bonds 52 that make up the pattern can be of any plan view shape. For instance, the bonds 52 can be in the form of straight or curved lines, geometric shapes such as circles, squares, rectangles, diamonds, and the like, or irregular shapes. In this embodiment, the fusion bonds 52 comprise a plurality of circular bonds.

The fusion bonds 52 may be of any suitable size, and may be distributed across the body-facing side 20A of the sanitary napkin in a range of suitable densities. The fusion bonds 52 preferably have a diameter that is greater than about 1 mm and ranges up to less than about 3 mm. In the sanitary napkins 20 shown in FIGS. 1 and 4, the fusion bonds are preferably about 1.5 - 2.0 mm in diameter. Providing fusion bonds within this range of sizes is preferred, especially with the DRI-WEAVE apertured film topsheet material. Providing fusion bonds 52 with smaller diameters creates manufacturing difficulties. In particular, difficulties are encountered because application of the pressure necessary to produce a bond by an element having a surface area less than about 1 mm in diameter will tend to perforate the apertured film topsheet material. Providing fusion bonds 52 with diameters greater than or equal to 3 mm in diameter has been found to negatively impact the consumer acceptance of the apertured film topsheet material. The apertured film is designed to allow liquids to pass through in one direction only. Providing bonds having such a larger size results in an increased belief that there will be a tendency for liquids to be "squeezed out" under pressure and pass back through the bonds and rewet the wearer's skin.

The edges of the fusion bonds 52 are preferably spaced more than about 0.5 mm apart in all directions. Closer bonds spacings have also been found to have a tendency to collapse the structure of the apertured film, which leads to higher rewet. The fusion bonds 52 are preferably distributed in a density that not only enhances the performance of the sanitary napkin, but also enhances the user's perception of the softness of the sanitary napkin and its absorbency. A bond density of between about 15-80 bonds per 9 cm² (including the area of the open window) is especially preferred for these purposes. Lower bond densities will tend to leave users with a perception of lower absorbency. Higher bond densities will tend to negatively impact absorbency.

The bond density need not be uniform over the entire surface of the sanitary napkin. For example, it will be appreciated from viewing FIGS. 1 and 4 that there will be areas on the surface of the sanitary napkin such as in the closed geometric figure (described below) surrounding the unbonded window 54 that will have bond densities at the higher end of this range, and other areas that will have bond densities at the lower end of this range. The fusion bonds 52 preferably cover between about 5% to about 15%, and more preferably about 8% to about 12% of the area on the surface of the sanitary napkin 20 that overlies the largest of the underlying absorbent layers.

In the embodiment shown in FIG. 1, the circular bonds 52 are arranged in a pattern that is preferably distributed over substantially the entire body surface 20A of the main

body portion of the sanitary napkin, with the exception of the unbonded window 54 in the liquid receiving zone of the sanitary napkin. In the embodiment of a thicker sanitary napkin shown in FIG. 4, the bonds 52 may only be distributed over substantially all of that part of the main body portion 22 of the sanitary napkin 20 that overlies the acquisition component 44 (which is in the form of a rectangular patch), with the exception of the unbonded window 54 in the liquid receiving zone of the sanitary napkin.

The liquid receiving zone is the portion of the sanitary napkin that lies under the perineal area of the wearer. Preferably, the area of the unbonded window 54 is at least as large as, or larger than the perineal area of the wearer. Preferably, this area is greater than about 1 centimeter wide in the transverse direction and greater than about 5 centimeters long. The size of the unbonded window 54, however, is preferably not so large that the apertured film 38 is capable of appreciably separating from contact with the underlying acquisition component 44 in the area of the unbonded window 54 due to the lack of bonding therein. In the sanitary napkin 20 shown in FIG. 1, the unbonded window 54 is preferably centered about the longitudinal and transverse centerlines. However, in other embodiments, particularly ones in which the sanitary napkin is asymmetrically-shaped about the transverse centerline, the unbonded window 54 may be offset forwardly or rearwardly relative to the transverse centerline.

In the preferred embodiment shown in FIG. 1, the unbonded window 54 is defined by a plurality of fusion bonds 52 arranged in the configuration of a closed geometric figure 56. The closed geometric figure 56 is formed by a plurality of fusion bonds 52 arranged in a number of opposed, concave inwardly-oriented curvilinear lines around the unbonded window 54. The width or transverse dimension of this figure is preferably about 0.75 inches (about 1.9 cm) at its narrowest point. The length or longitudinal dimension of this figure is preferably about 3.5 inches (about 8.9 cm) as measured along the longitudinal centerline of the sanitary napkin 20.

The curvilinear lines forming the closed geometric figure preferably include a pair of longitudinally-oriented concave lines 56A. The longitudinally-oriented concave lines 56A preferably each comprise two rows of bonds where the bonds 52 in adjacent rows are arranged in a side-by-side fashion. These bonds 52 are preferably relatively closely spaced. These bonds 52 may, if desired, be designed to wick liquids in the longitudinal direction and provide a barrier to the flow of exudates in the transverse direction, particularly menses, so that menses will not approach the longitudinal side edges 26 of the sanitary napkin 20. The ends of the closed geometric figure that surrounds the unbonded window 54 are preferably formed by curvilinear lines 56B that form cusp-shaped figures.

The intersection of the two arcs comprising the cusp-shaped figures lies along the longitudinal centerline of the sanitary napkin. These curvilinear lines 56B forming the cusp-shaped figures preferably also comprise roughly two rows of bonds, but these bonds are not exactly in a side-by-side pattern.

There are also bonds 52 located longitudinally and laterally outboard of the closed geometric figure 56. The fusion bonding preferably surrounds the unbonded window 54. The fusion bonds 52 are preferably located in the first end region 32, the second end region 34, and in longitudinal side regions 18 of the sanitary napkin 20. In the embodiment shown in FIG. 1, the fusion bonds 52 outside the unbonded window 54 are preferably distributed over substantially all of the body-facing side 20A of the main body portion 24 of the sanitary napkin that is inboard of any perimeter seal. These latter bonds 52 can also be arranged in a number of suitable patterns. Preferably, the bonding forms a "quilted pattern". More specifically, the bonds 52 are preferably arranged in a pattern that comprises a plurality of circular bonds arranged in a diamond-shaped figure 57A. The bonds that form the diamond-shaped figure 57A preferably enclose a plurality of bonds that also form a figure 57B. This enclosed figure 57B may range from a modified (or rounded) diamond shape to an oval shape. In the longitudinal side regions 18, only a portion of the diamond-shaped figures are present due to space constraints. For processing reasons, most of the bonds in the quilted pattern are preferably spaced apart in the longitudinal direction a distance that is equal to the radius of the bonds multiplied by the square root of three.

The acquisition component 44 can also be at least partially joined to the topsheet 38 by adhesives. If adhesives are used, the adhesives can be distributed across the entire interface between the topsheet 38 and the acquisition component 44. Preferably, however, the adhesives are not applied between these two components in the region of the unbonded window 54. Any suitable adhesives can be used for this purpose, with wet strength adhesives being preferred. Wet strength adhesives are those that retain their ability to bond in the presence of liquids. Suitable wet strength adhesives are described in U.S. Patent 5,460,622 issued to Dragoo, et al. on October 24, 1995.

If adhesives are used, they should not interfere with the transfer of liquids from the topsheet to the underlying acquisition layer or other underlying layers. The adhesives can be applied in a uniform continuous layer like meltblown fibers of adhesive, or a patterned layer, an array of separate lines, spirals, or spots of adhesive. The adhesive attachment means preferably comprises an open pattern network of filaments of adhesive as is disclosed in U.S. Pat. No. 4,573,986 issued to Minetola, et al. on March 4, 1986, or an

open pattern network of filaments comprising several lines of adhesive filaments swirled into a spiral pattern as illustrated by the apparatus and method shown in : U.S. Pat. No. 3,911,173 issued to Sprague, Jr. on October 7, 1975; U.S. Pat. No. 4,785,996 issued to Ziecker, et al. on November 22, 1978; and U.S. Pat. No. 4,842,666 issued to Werenicz on June 27, 1989.

The bonding of the acquisition component 44 to the underside of the topsheet 38 over substantially the entire surface of the body-facing side 20A provides several advantages. The bonding of the acquisition component 44 to the topsheet maintains an absorbent component in constant contact with the topsheet for improved acquisition. It also prevents the topsheet from separating from the underlying absorbent component and moving into the crevices in the wearer's body to cause discomfort.

The strength of the attachment between these layers is improved relative to the adhesively attached layers of currently marketed ALWAYS ULTRA sanitary napkins. Because of this improved attachment and the resilient nature of the materials comprising the acquisition layers, the sanitary napkin 20 is less subject to undesirable bunching in use and is, therefore, better able to cover a maximum area of the wearer's panties (that is, "area coverage" is improved). In the case of thicker sanitary napkins, the integrity of the sanitary napkin is greatly improved in comparison to thick sanitary napkins having airfelt absorbent cores under wet conditions. Typically, in sanitary napkins having airfelt cores, the airfelt will tend to collapse and slump and/or form balls or harder areas when wetted. In the case of thicker sanitary napkins provided with the features of the present invention, however, the force required to bunch the sanitary napkin is very close regardless of whether the sanitary napkin is wet or dry. This indicates that resistance to bunching is similar under wet and dry conditions.

In addition, the unbonded window 54 provides the body-facing side 20A of the sanitary napkin 20 with a region in the liquid receiving zone that is free of bonded areas to eliminate any interference with the acquisition of liquids caused by the presence of the bonds and to maximize the liquid handling capability of the sanitary napkin.

The absorbent core 42 lies under the acquisition component 44. The absorbent core 42 may be any absorbent means that is capable of absorbing or retaining liquids (e.g., menses and/or urine). The absorbent core 42 has a body-facing surface, a garment-facing surface, side edges, and end edges. The absorbent core 42 may be manufactured in a wide variety of sizes and shapes (e.g., rectangular, oval, hourglass, dog bone, asymmetric, etc.). In the preferred embodiment shown in FIG. 1 of the drawings, the absorbent core 42 is rectangular and is of a size that is slightly smaller than the periphery of the acquisition

component 44. In the embodiment shown in FIG. 4, the absorbent core 42 is dog bone shaped, and is larger than the acquisition component 44.

The absorbent core 42 can be manufactured from a wide variety of liquid-absorbent materials commonly used in sanitary napkins and other absorbent articles. Examples of suitable absorbent materials include comminuted wood pulp which is generally referred to as airfelt; creped cellulose wadding; meltblown polymers including coform; chemically stiffened, modified or cross-linked cellulosic fibers; synthetic fibers such as crimped polyester fibers; peat moss; tissue including tissue wraps and tissue laminates; absorbent foams; absorbent sponges; superabsorbent polymers; absorbent gelling materials; or any equivalent material or combinations of materials, or mixtures of these. The configuration and construction of the absorbent core may also be varied (e.g., the absorbent core may have varying caliper zones (e.g., profiled so as to be thicker in the center), hydrophilic gradients, superabsorbent gradients, or lower density and lower average basis weight acquisition zones; or may comprise one or more layers or structures). The total absorbent capacity of the absorbent core should, however, be compatible with the design loading and the intended use of the sanitary napkin. Further, the size and absorbent capacity of the absorbent core may be varied to accommodate different uses such as incontinence pads, pantliners, regular sanitary napkins, or overnight sanitary napkins.

In the preferred embodiment shown in the drawings, the absorbent core 42 preferably comprises a multi-bonded air laid material. In this preferred embodiment, this multi-bonded air laid material comprises about 50% to about 70% cellulose fibers, about 12% to about 20% bi-component fibers, about 10% to about 30% superabsorbent hydrogel-forming material (or absorbent gelling material) particles, and about 3% latex. The absorbent core 42 preferably has a caliper of about 1.5 mm under a pressure of 68.9 Pascals, and a basis weight of about 125 g/yd² (about 150 g/m²), including the particles of absorbent gelling material (although much higher basis weight materials can also be used). Preferably, this multi-bonded air laid absorbent core 42 is formed by depositing three streams of cellulose and bi-component fibers, with absorbent gelling material particles 58 laid down with the last stream of fibers to form the bottom portion of the absorbent core. While the absorbent core 42 is shown as a laminate in FIGS. 2 and 3, in preferred embodiments, the fibers are blended together to form a single web. Such a multi-bonded air laid material is preferably obtained in roll form as product 915000X313 from Merfin Hygienic Products.

In alternative embodiments, the multi-bonded air laid material used for the absorbent core can be bonded using some material other than latex (such as starch or

PVA, for example). In another alternative embodiment, the absorbent core can be formed as a laminate that preferably also has a basis weight of about 150 g/m^2 and comprises two (or more) layers of multi-bonded air laid nonwoven material with the particles of absorbent gelling material therebetween. Suitable laminate absorbent core structures are described generally in U.S. Patents 4,950,264 and 5,009,653 issued to Osborn, U.S. Patent 5,460,623 issued to Emenaker, et al. Another suitable absorbent core is described in U.S. Patent Application Serial No. 08/122,114, entitled "Sanitary Napkin Having Core Predisposed To A Convex Upward Configuration", filed in the name of Hines, et al. on September 16, 1993 (PCT Publication No. WO 95/07674, published March 23, 1995).

In the above embodiments, or in other alternative embodiments, the absorbent core 42 can be provided with a feature to further improve its flexibility. Such a feature could include, but is not limited to one or more slits, perforations, embossments, or score lines in the absorbent core 42 or acquisition component 44. This type of feature is preferably arranged to improve flexibility about the principal longitudinal centerline of the sanitary napkin. The slits, perforations, embossments, or score lines can be in any suitable configuration. Suitable configurations include, but are not limited to straight or curved lines, slits, dots, V-shaped patterns, W-shaped patterns, or the like. The slits, perforations, embossments, or score lines, or any combination thereof can be provided in any of the layers of the laminate absorbent cores described above. One example of a feature that will improve the flexibility of the absorbent core 42 is a score line in the absorbent core that runs along the principal longitudinal centerline of the sanitary napkin.

In the case of thicker sanitary napkins, the absorbent core 42 is preferably comprised of airfelt. Suitable absorbent cores for thicker sanitary napkins are described in U.S. Patent 5,234,422 issued to Sneller, et al. In a preferred embodiment, the topsheet 38, acquisition component 44, and absorbent core 42 can be provided with embossed channels as shown in the Sneller, et al. patent. As shown in FIG. 4, if such embossed channels 59 are used, they preferably lie laterally outside of the longitudinally-oriented concave lines 56A defining the sides of the unbonded window 54.

The backsheet 40 prevents the exudates absorbed and contained in the absorbent core 42 from wetting articles which contact the sanitary napkin 20 such as pants, pajamas and undergarments. The backsheet 40 is preferably resistant to the flow of liquids, and more preferably is impervious to liquids (e.g., menses and/or urine). The backsheet 40 is preferably manufactured from a flexible material. As used herein, the term "flexible" refers to materials which are compliant and will readily conform to the general shape and contours of the human body. The backsheet 40 may comprise a woven or nonwoven

material, polymeric films such as thermoplastic films of polyethylene or polypropylene, or composite materials such as a film-coated nonwoven material. Preferably, the backsheet 40 is a polyethylene film having a thickness of from about 0.012 mm (0.5 mil) to about 0.051 mm (2.0 mils). The backsheet 40 may be embossed and/or matte finished to provide a more clothlike appearance. Further, the backsheet 40 may permit vapors to escape from the absorbent core 42 (i.e., breathable) while still preventing exudates from passing through the backsheet 40. A suitable backsheet material is obtained as product No. 18-1401 from the Clopay Corporation of Cincinnati, Ohio. A suitable breathable backsheet material is a laminate of an apertured film such as that described in U.S. Patent 3,929,135 issued to Thompson which is inverted so that the smaller openings of the tapered capillaries face the absorbent core 42 which is adhesively laminated to a microporous film such as that described in Exxon's U.S. Patent 4,777,073.

Materials regarded as "breathable" in the context of the present invention include not only those materials which are apertured, microapertured, or otherwise rendered physically porous, but also substantially non-porous "monolithic" polymeric materials (typically films) made from such materials as polyurethanes, block poly-ether-amides, block polyesters, EVA, ethylene/acrylic ester copolymers, and PVP copolymers. Suitable materials include films formed from a block polyether copolymer such as a block polyether ester copolymer, a polyetheramide copolymer, a polyurethane copolymer, a poly(etherimide) ester copolymer, polyvinyl alcohols, or a combination thereof. Preferred copolyether ester block copolymers are segmented elastomers having soft polyether segments and hard polyester segments, as disclosed in Hagman, U.S. Patent No. 4,739,012. Suitable copolyether ester block copolymers are sold by DuPont under the name Hytrel®. Hytrel® is a registered trademark of DuPont. Suitable copolyether amide polymers are copolyamides available under the name Pebax® from Atochem Inc. of Glen Rock, New Jersey, USA. Pebax® is a registered trademark of Elf Atochem, S.A. of Paris, France. Suitable polyurethanes are thermoplastic urethanes available under the name Estane® from The B.F. Goodrich Company of Cleveland, Ohio, USA. Suitable copoly(etherimide) esters are described in Hoeschele et al. U.S. Patent 4,868,062. Such materials are regarded as breathable in contrast to substantially non-breathable materials such as non-apertured polyethylene films. Breathability may be determined by any suitable test method, such as, for example, the ASTM E-96 "Upright Cup" method. The adhesive systems of the present invention, as described in detail below, are believed to provide particular advantages in terms of unoccluded breathable surface area versus conventional adhesive system.

The topsheet 38, the acquisition component 44, the backsheet 40, and the absorbent core 42 may be assembled in a variety of configurations known in the art (including layered or "sandwich" configurations and wrapped or "tube" configurations). Figures 1-3 show a preferred embodiment of the sanitary napkin 20 assembled in a sandwich construction. In FIGS. 1-3, the topsheet 38 and the backsheet 40 have length and width dimensions generally larger than those of the absorbent core 42. The topsheet 38 and the backsheet 40 extend beyond the edges of the absorbent core 42 to form portions of the periphery 30. The garment-facing side of the topsheet 38 is preferably joined to the body-facing side of the acquisition component 44 as described above. The acquisition component 44 may be joined to the absorbent core 42, if desired. If these components are joined, they can be joined in any of the manners described herein for joining the topsheet 38 to the acquisition component 44. However, in the embodiment shown in the drawings, the acquisition component 44 is not directly joined to the absorbent core 42. The backsheet 40 is preferably joined to the garment-facing side of the absorbent core by adhesives.

The portions of the topsheet 38 and backsheet 40 that extend beyond the edges of the absorbent core 42 and the acquisition component 44 are preferably also joined to each other. These portions of the topsheet 38 and backsheet 40 can be joined in any suitable manner known in the art. The term "joined", as used in this specification, encompasses configurations in which an element is directly secured to another element by affixing the element directly to the other element; configurations in which the element is indirectly secured to the other element by affixing the element to intermediate member(s) which in turn are affixed to the other element; and configurations in which one element is integral with another element, i.e., one element is essentially part of the other element. Preferably, in the embodiment shown, these portions of the topsheet 38 and backsheet 40 are joined using adhesives over substantially the entire portions that extend beyond the edges of the absorbent core 42 and a crimp seal at the end edges 28 of the main body portion where the topsheet 38 and backsheet 40 are densified by the application of pressure or heat and pressure.

The sanitary napkin 20 shown in FIGS. 1-3, as discussed above, comprises an optional pair of flaps 24 that are joined to the main body portion 22. The flaps 24 extend laterally outward beyond the longitudinal side edges 26 of the main body portion 22 from their proximal edges 60 to their distal edges (or "free end") 62. The flaps 24 extend outward from at least the central region 36 of the main body portion 22. As shown in Figure 1, each flap 24 is divided into a front half 64, and a back half 66 by a flap

transverse centerline T_1 . The flap transverse centerline T_1 may coincide with the principal transverse centerline T of the sanitary napkin, but this is not absolutely required.

The flaps 24 can be joined to the main body portion 22 in any suitable manner. Preferably, in the embodiment shown in FIGS. 1-3, the flaps 24 are integral with the main body portion 22 (that is, the flaps 24 comprise integral extensions of the topsheet 38 and backsheet 40). In other alternative embodiments, the flaps 24 can comprise separate components that are joined to the main body portion 22. The flaps 24 are each joined to (or associated with) main body portion 22 along a juncture. This is typically a longitudinally-oriented (or "longitudinal") juncture, such as lines of juncture 68. As used herein, the terms "junction" (or "line of junction") refer to regions where the flaps 24 extend from or are joined to the main body portion 22. The line of juncture 68 in the embodiment illustrated in the drawings can be considered to be defined by concave inwardly-oriented regions or lines.

The flaps 24 can be in any suitable configuration. Suitable flaps are described in Reexamined Patent No. B1 4,589,876 entitled "Sanitary Napkin", issued to Van Tilburg, Certificate of Reexamination issued April 27, 1993; U.S. Patent 4,687,478 entitled "Shaped Sanitary Napkin With Flaps", which issued to Van Tilburg on August 18, 1987; U.S. Patent 5,389,094 entitled "Absorbent Article Having Flaps and Zones of Differential Extensibility" issued to Lavash, et al. on February 14, 1995; U.S. Patent 5,558,663 entitled "Absorbent Article Having Undergarment Covering Components With Zones of Extensibility" issued to Weinberger, et al. on September 24, 1996 (which describes an alternative to flaps that are applied by the wearer); and in International Patent Application Serial No. PCT US 96/15957 entitled "Absorbent Article Having Flaps With Step Configuration and Zones of Extensibility" filed on October 3, 1996, in the name of Lash, et al.

The sanitary napkin 20 shown in FIGS. 1-3 preferably has a deformed region that forms a hinge 70 between the main body portion 22 and at least a portion of the flaps 24. The sanitary napkin 20 preferably also has at least one zone of extensibility (or "zone of differential extensibility") 72 for relieving the stresses on the flaps 24 when they are folded around a panty crotch. These features are each described below.

In the sanitary napkin shown in FIGS. 1 - 3, the hinge 70 comprises a generally longitudinally-oriented, mechanically-deformed region. The hinge 70 provides a region of the sanitary napkin 20 with increased flexibility to create preferred bending axes for the flaps 24 to bend or fold about. The hinge 70 is preferably located in a region along the juncture 68 of the flaps 24 with the main body portion 22. The hinge 70 can extend along

the entire juncture 68 of the flaps with the main body portion, or along only a portion thereof. If the hinge 70 is only provided along a portion of the juncture 68, it is preferably provided in the region of the sanitary napkin 20 surrounding and including the flap transverse centerline T_1 . The hinge 70 has a laterally inwardmost, or proximal, boundary 70A and an outermost, or distal, boundary 70B. In the embodiment shown in FIGS. 1-3, at least the inwardmost boundary 70A of the hinge 70 is preferably concave inwardly relative to the distal edge of the flaps 24.

The hinge 70 can be formed in any suitable manner that provides the desired region of the sanitary napkin with increased flexibility. Preferably, the hinge 70 is formed by mechanically deforming the desired regions of the sanitary napkin. It has been found that many processes suitable for providing regions of the sanitary napkin with extensibility are particularly suitable for providing regions of the sanitary napkin selected for the hinge 70 with enhanced flexibility. The hinge 70 can, for instance, be formed by a process which has been described as pre-corrugating (or "ring rolling"), or by a process that involves forming a strainable network in the desired portion of the sanitary napkin. Suitable methods for ring rolling are described in U.S. Patent 4,107,364 issued to Sisson on August 15, 1978, U.S. Patent 5,143,679 issued to Gerald M. Weber, et al. on September 1, 1992, U.S. Patent 5,156,793 issued to Kenneth B. Buell, et al. on October 20, 1992, and U.S. Patent 5,167,897 issued to Gerald M. Weber, et al. on December 1, 1992. Preferably, as shown in FIG. 1, the hinge 70 is provided by forming a strainable network region along the juncture 68 of the flaps 24 with the main body portion 22. The process for forming a strainable network region, and structures formed thereby are described in greater detail in U.S. Patent 5,518,801 issued to Chappell, et al. on May 21, 1996.

The term "strainable network", as used herein, refers to an interconnected and interrelated group of regions which are able to be extended to some useful degree in a predetermined direction. The strainable network 74 comprises at least two distinct and dissimilar regions which are designated as first region 76 and second region 78. In the embodiment shown, the strainable network 74 includes a plurality of first regions 76 and a plurality of second regions 78. As shown in FIGS. 1-3, the first regions 76 are substantially planar regions. That is, the material within the first region 76 is in substantially the same condition before and after the formation of the strainable network 74. The second regions 78 include a plurality of continuous, interconnected, rib-like deformations 80 which extend alternately beyond the plane of both surfaces of the first region 76.

FIG. 1 shows that the flap material 24 having the strainable network 74 formed therein has a longitudinal centerline (or axis), 1. In the sanitary napkin embodiment shown in FIG. 1, the longitudinal centerline, 1, of the strainable network 74 is rectilinear and generally oriented in the transverse direction. In the sanitary napkin 20 shown in FIG. 1, the first regions 76 are substantially linear, extending continuously in a direction substantially parallel to the longitudinal axis 1 of the strainable network.

The hinge 70 is created by forming the strainable network 74 into the desired portion of the sanitary napkin 20. As used herein, the term "forming" refers to the creation of a desired structure or geometry upon a web material or laminate that will substantially retain the desired structure or geometry when it is not subjected to any externally applied elongations or forces. Suitable methods for forming a strainable network into a web material include, but are not limited to embossing by mating plates or rolls, thermoforming, high pressure hydraulic forming, and casting.

The depth and number of deformations 80 in the strainable network 74 can be varied to control the applied force or elongation required to extend the material in the hinge regions 70 of the sanitary napkin 20. In one embodiment, the deformations 80 may be formed by two rigid plates having a pattern of meshing teeth. The outer dimensions of the pattern of teeth covers a surface area of the plates that is about 7.9" by 1.6" (20 cm by 4 cm) for each flap. On one surface of each plate are a series of teeth which are substantially triangular in cross section and taper to a radiused vertex. The teeth in this embodiment preferably have a height of 3.175 mm, and are evenly spaced with the centerlines of the teeth spaced apart at 0.075" (1.9 mm) increments. On the "toothed" side of one plate, a series of grooves (preferably three grooves to construct the embodiment shown in FIG. 1) are cut which are parallel to each other and perpendicular to the evenly spaced teeth. These grooves correspond to the undeformed regions of the base material.

The preferred base material is placed between the plates in a hydraulic press having platens larger than the plates to evenly distribute pressure. The plates are compressed so that the teeth only partially engage (or mesh). Preferably, the plates are moved so that the teeth on the opposite plates are pressed toward each other about 80% of the distance toward full engagement (the point where the teeth would otherwise touch). Typically, in order to do this, when the base material comprises a laminate of apertured formed film and polyethylene backsheet material laminated together by adhesives that is described in conjunction with the embodiment shown in FIGS. 1-3, the plates will be compressed under a load of between about 25 - 70 psi. (about 1,750-4,900 g/cm²). The formed web

material is then removed from between the plates. In the embodiment shown in FIGS. 1-3, the formed web material is provided with about 75% extensibility.

The strainable network region 74 comprises alternating ridges and valleys that form a plurality of flexible bending axes for the flaps 24. This structure also provides the hinge 70 with a degree of extensibility. The extensibility allows the portions of the flaps 24 in the hinge region 70 to expand slightly in the transverse direction to better fold around the curved sides of the wearer's panty crotch. Providing the hinge 70 by forming strainable network regions in the sanitary napkin may also be preferred when it is desired to provide the formed regions with slightly more integrity so the flaps 24 will be less likely to droop excessively at the hinge 70 because the unformed first regions or less extensible bands 76 of the strainable network will serve like "beams" that tend to provide the flaps 24 with slightly more structural rigidity and better appearance.

The sanitary napkin also preferably has zones of extensibility 72 for relieving the stresses that develop in the flaps when they are folded down and under a wearer's undergarment. The terms "zone of extensibility" or "zone of differential extensibility", as used herein, refer to a portion of the sanitary napkin 20 which is capable of extending (and are preferably capable of extending a greater amount than surrounding portions of the sanitary napkin 20). The sanitary napkin 20 preferably has at least one zone of extensibility 72 for each flap 24, and more preferably has four zones of extensibility 72, one in each quarter of the sanitary napkin 20. Since the zones of differential extensibility 72 relieve stresses in the flaps, they may be referred to herein as a type of "stress relief means".

The zones of extensibility 72 can be extensible in any desired direction, or in more than one direction. However, the zones of extensibility 72 are preferably primarily extensible generally outward in the transverse direction. This is generally in the direction of the arrows shown in Figure 1. As used herein, "generally in the transverse direction" means that the extensibility has a transverse component. All of the extension, however, need not be exactly parallel to the principal transverse centerline of the sanitary napkin. The extensibility, however, is preferably oriented more in the transverse direction than in the longitudinal direction. The zones of extensibility 72 can comprise any structure capable of extending in the transverse direction (or in any other direction desired). Suitable structures for the zones of extensibility are described in greater detail in U.S. Patent 5,389,094 issued to Lavash, et al. on February 14, 1995. In the embodiment shown in FIG. 1, the zones of extensibility 72 can either comprise ring rolled regions of the flaps or a network of corrugations without any less extensible bands therein. In either case, the

zones of extensibility 72 preferably have corrugations with ridges 88 that are oriented generally in the longitudinal direction so that the zones of extensibility 72 will be extensible primarily in the transverse direction.

Preferably, as shown in Figure 1, the hinge 70 is contiguous (that is, touching or connected throughout in an unbroken sequence) with the zones of extensibility 72. The hinge 70 and the preferred ring rolled zones of extensibility 72 are, thus, portions of a continuous composite deformed region. As shown in FIG. 1, the hinge 70 gradually transitions into portions of the sanitary napkin that comprise the zones of extensibility 72. The composite deformed region, thus, comprises continuous corrugations having ridges that are generally oriented in the longitudinal direction with a plurality of less extensible bands 76 in the center region adjacent the flap transverse centerline T₁.

Numerous other embodiments of the sanitary napkin 20 are possible. For example, the main body portion of the sanitary napkin can be provided in the form of a compound sanitary napkin that has its components bonded as described herein for improved integrity and acquisition. General descriptions of compound sanitary napkins are found in P&G's U.S. Patent 4,425,130 entitled "Compound Sanitary Napkin" issued to DesMarais, et al. on January 10, 1984, and in Statutory Invention Registration H1614 entitled "Body Fitting Compound Sanitary Napkin", published in the name of Mayer, et al. on November 5, 1996. To form the compound sanitary napkin, a sanitary napkin such as that described herein can serve as the panty protector (or "base pad") and a tube of absorbent material wrapped by a topsheet (or "primary menstrual pad") can be placed on top of the sanitary napkin and attached thereto at the ends. The fusion bonding on the base pad is preferably distributed in the same manner as shown on the drawings herein. The attachment of the tube to the sanitary napkin is preferably achieved by fusion bonding extensions of the topsheet material at the ends of the tube to the base pad. In some preferred embodiments of such a compound sanitary napkin, there may also be attachment between the ends of the tube of absorbent material and the base pad. The tube of the compound sanitary napkin can be attached to the base pad between its ends by any suitable attachment means, such as by adhesives.

It is believed that the improved attachment between the topsheet and acquisition component in the base pad may have a particular advantage in the context of a compound sanitary napkin. Without wishing to be bound by any particular theory, it is believed that the improved attachment will result in a reduced tendency for the topsheet to separate from the underlying components along the longitudinal side regions of the sanitary napkin. This is believed to be particularly important on versions of a compound sanitary

napkin having flaps. The fusion bonding ensures that the portion of the topsheet in the longitudinal side regions of the base pad will not move into contact with the wearer's body. This will reduce the tendency for the longitudinal side regions to be soiled by menses, and menses will instead proceed directly into the absorbent tube.

Other advantages from the bonding described herein are also possible. For example, when the sanitary napkin is provided with flaps, the portion of the topsheet and backsheet that are joined together to form the flaps of the sanitary napkin may be substantially free of adhesive between the parts of the same to leave a "glue-free window" in a portion of the flaps. A suitable sanitary napkin that can have a glue-free window in its flaps is described in European Patent Application EP 0 695 542 A1 entitled "Absorbent Article Having Undergarment Side Wrapping Elements", published in the name of Coles, et al. on February 7, 1996. In such embodiments, the topsheet and backsheet are, however, preferably bonded to each other at least along the entire perimeter of the flaps and in any extensible portions of the flaps.

Providing a sanitary napkin having flaps with a glue-free window has the advantage of providing the flaps with increased flexibility in the area of the glue-free window. This is due to the absence of adhesive in this portion of the flaps and the fact that the portions of the topsheet and backsheet forming the flaps can fold independently of each other in the glue-free window. A potential disadvantage of the glue-free window, however, is that the topsheet may tend to billow or "blouse" and separate from the backsheet, particularly when it is folded around the sides of the wearer's undergarment. Without wishing to be bound by any particular theory, it is believed that the improved attachment described herein will better keep the topsheet attached to an underlying component and reduce such blousing. In this embodiment, and all of the other embodiments described herein, it is believed that the improved attachment between the topsheet and the underlying component(s) will result in menses being absorbed better and hidden from view (or "masked"), and will reduce the tendency for menses to "run off" the topsheet.

In addition, it is also possible to form a sanitary napkin (or other absorbent article) with a pattern of embossments with the characteristics of the bond areas on the sanitary napkin described above. Such an absorbent article may be less preferred, but it will provide the consumer benefits of increasing the wearer's confidence in the softness, absorbency, and reduction in rewet associated with the absorbent article.

Adhesive Systems:

In accordance with the present invention, the garment surface 20B of the sanitary napkin 20 includes fasteners for attaching the sanitary napkin to the wearer's undergarment. Figure 5 shows a preferred configuration wherein the adhesive system includes a central pad adhesive fastener 82 and a flap adhesive fastener 84 adjacent the distal edges 62 of the flaps. The central pad fastener 82 is adapted to secure the main body portion 22 of the sanitary napkin to the crotch region of an undergarment. The flap adhesive 84 is used to assist in maintaining the flaps 24 in position after they are wrapped around the edge of the crotch portion of the panty. The flaps 24 can be maintained in position by attaching the flaps 24 to the undergarment, or to the opposing flap. The adhesive system fasteners 82 and 84 can be unitarily formed with the backsheet and/or flap material or can be formed as a separate material element and adhered to the backsheet and/or flap material. Adhesive systems of the present invention may be positioned on the backsheet, on the flaps, or on both regions of the absorbent articles.

In the embodiment shown in Figure 5, the central pad fastener 82 is "zoned" so as to avoid the two regions of the sanitary napkin where fold lines are formed in the customary "tri-folded" configuration. In addition, the central pad fastener 82 is also formed separately from the flap adhesive 84 to likewise avoid the regions of folding where the flaps are joined to the main body of the sanitary napkin. However, for some applications it may be suitable and in fact desirable to form a single expansive adhesive system 86 which substantially covers the entire garment-facing surface 20B of the sanitary napkin, as shown in Figure 6.

The adhesive system of the present invention depicted in Figures 1-6 is a selectively activatable adhesive-bearing structure which bonds opposing material surfaces to one another. The target surface for the adhesive system may comprise a separate element (such as an undergarment) or may comprise another region of the absorbent article itself.

As utilized herein, the term "selectively activatable" is used to refer to materials which exhibit substantially non-adherent properties when brought into contact with target surfaces until some action is taken by a user to "activate" the material to reveal adhesive properties. Accordingly, selectively-activatable properties differ from permanently-active strips of adhesive which rely upon removal of liner materials (typically silicone-coated paper strips or films) to expose the adhesive for use.

Selective activation of such materials allows the user to properly position opposing surfaces before activation and adhesion are accomplished, as well as minimizing the likelihood of contamination of the adhesive system before use. This characteristic

permits the absorbent article to be manipulated in any desired mode without encountering the difficulties of premature clinging or adhering of the adhesive system to itself or to other portions of the absorbent article or the wearer's body, and without the need for separate release sheets, liners, spacers, or the like which often need to be removed prior to contact with the target surface. If desired, the selective activation process may be reversible such that the adhesive system may be de-activated for removal of the absorbent article and then re-activated for repositioning or further use without significant loss of adhesive capability.

Although under some circumstances it may be acceptable or desirable to design the adhesive system so as to form a discontinuous bond pattern with itself or another target surface, such as by having an intermittent or discontinuous layer of adhesive on its active surface, it is presently preferred that the adhesive system be designed so as to exhibit the ability to form a continuous network of adhesion or bond with itself and with any sufficiently continuous target surface.

Regardless of the manner of activation, materials useful as an adhesive system in accordance with the present invention will exhibit an adhesive, adherent, or tacking character as opposed to merely a clinging or affinity character. As utilized herein, therefore, the term "adhesive" is utilized to refer the ability of a material to exhibit an adherent character whether or not it actually includes a composition commonly understood and labelled as an adhesive. Accordingly, such materials will form a bond or seal when in contact with itself or another target surface as opposed to merely being attracted to such surface. While a number of approaches such as the use of selectively adherent materials may be utilized to provide the desired adhesive properties, a presently preferred approach is to utilize a pressure-sensitive adhesive.

When designing materials useful as an adhesive system in accordance with the present invention, it may be desirable to tailor the particular choice of adhesive agent so as to provide either a permanent bond or a releasable bond as desired for a particular application. Where a permanent bond is desired, removal of the absorbent article requires destruction of the absorbent article and/or the undergarment to which it is secured. Releasable bonds, on the other hand, permit separation of the adhesive system from itself or from an undergarment at the bond site without destruction. Moreover, depending upon the activation mechanism employed in the design of the material, the releasable bond may additionally be refastenable if sufficient adhesive character remains after the initial activation/bonding/release cycle.

The adhesive systems useful in the present invention exhibit an adhesion sufficient to survive the likely degree of handling and external or internal forces the adhesive system is likely to encounter in use while maintaining the desired level of adhesion with the undergarment. In general, minimum adhesion which maintains a bond is desired, so that the adhesive system is easily peeled off of the undergarment for removal.

Figures 7 and 8 illustrate a preferred embodiment of a material useful as an adhesive system for use with absorbent articles according to the present invention, which comprises a three-dimensional sheet-like structure generally indicated as 88. Material 88 includes a deformed material 83 having hollow protrusions 85 and a layer of substance (adhesive) 87 located between protrusions 85. Protrusions 85 are preferably conical in shape with truncated or domed outermost ends 89. Protrusions 85 are preferably equally spaced in an equilateral triangular pattern, all extending from the same side of the material. Protrusions 85 are preferably spaced center to center a distance of approximately two protrusion base diameters or closer, in order to minimize the volume of valleys between protrusions and hence the amount of substance located between them. Preferably, the protrusions 85 have heights which are substantially less than their diameters, so that when they deform, they deform by substantially inverting and/or crushing along an axis which is substantially perpendicular to a plane of the material. This protrusion shape and mode of deforming discourages protrusions 85 from folding over in a direction parallel to a plane of the material so that the protrusions cannot block substance between them from contact with a target surface.

Suitable representative three-dimensional materials of the type depicted in Figures 7 and 8 which include a thin layer of pressure-sensitive adhesive protected from inadvertent contact, as well as methods and apparatus for manufacturing them, have been developed and are described in detail in commonly-assigned U.S. Patent Nos. 5,662,758, issued September 2, 1997 to Hamilton and McGuire, entitled "Composite Material Releasably Sealable to a Target Surface When Pressed Thereagainst and Method of Making", and 5,871,607, issued February 16, 1999 to Hamilton and McGuire, entitled "Material Having A Substance Protected by Deformable Standoffs and Method of Making", and commonly-assigned, co-pending U.S. Patent Application Nos. 08/745,339 (allowed), filed November 8, 1996 in the names of McGuire, Tweddell, and Hamilton, entitled "Three-Dimensional, Nesting-Resistant Sheet Materials and Method and Apparatus for Making Same", 08/745,340, filed November 8, 1996 in the names of Hamilton and McGuire, entitled "Improved Storage Wrap Materials", all of which are hereby incorporated herein by reference.

The sanitary napkin 20 of the present invention is utilized by placing the sanitary napkin 20 in a panty and compressing the adhesive regions 82 and 84 to activate the adhesive and adhere the sanitary napkin to the panty. The main body portion 22 is placed in the crotch portion of the panty with one end of the main body portion 22 extending towards the front section of the panty and the other end towards the back section of the panty. The backsheet 40 is placed in contact with the inner surface of the center of the crotch portion of the panty. The central pad adhesive fastener 82 maintains main body portion 22 in position. The distal portions of the flaps 24 are folded around the side edges of the panty. The flap adhesives 84 secure the flaps 24 to the underside of the panty or to the opposing flap.

The use of an adhesive system such as depicted in Figures 5-8 provides unexpected advantages in comparison with conventional adhesive systems.

As discussed in the above-referenced and above-incorporated 5,871,607 Hamilton et al. patent, "The more protrusion [sic] per unit area, the thinner the piece of material and protrusion walls can be in order to resist a given deformation force. In a preferred embodiment the number of protrusions per square inch exceeds 200 and the protrusions occupy from about 30% to about 70% of the protrusion side of the piece of material." In the context of an absorbent article such as a sanitary napkin, the application of these principles permits the use of thin, flexible materials for the adhesive-bearing material which are not only able to provide sufficient resistance to deformation to prevent premature activation, but also sufficiently flexible to maintain the foldability of the article as well as comfort and conformability in use. Thus, unexpectedly a compression-activated adhesive structure can be incorporated into an absorbent article without substantially impairing its flexibility. Not only does this provide for an absorbent article which is conformable and comfortable in use, but also capable of being folded even in regions where the adhesive system is located.

Another feature or characteristic discussed in the aforementioned Hamilton et al. patent is the structural design of the protrusions. "Protrusions where at least a portion of the sidewalls are substantially thinner than the unformed material adjacent to the base perimeter are believed preferred for deformation by the user." In the context of breathable backsheet materials, quite unexpectedly it has been observed that such thinner sidewalls provide enhanced breathability per unit area for such sidewall regions. References in the prior art of adhesive coatings on breathable substrates have gone so far as to postulate that the loss of breathability was proportional to the percentage of obscured projected surface area. However, with the adhesive systems of the present invention it has been found that

the protrusions not only provide for both more unobstructed surface area and an increase in surface area due to their three-dimensional nature, but due to this sidewall thinning they also provide an increased level of breathability per unit area. With such adhesive systems, it is therefore possible to design absorbent articles which exhibit not only comparable breathability to non-adhesive-coated absorbent articles, but in fact enhanced breathability versus such non-adhesive-coated (or low-percentage-coated, i.e., stripes or patterns of adhesive) articles.

The number density of protrusions, i.e., the number of protrusions per square inch, is therefore an important parameter in the context of the present invention which also governs the thinness and flexibility of materials suitable for use as adhesive system substrates. Adhesive systems of the present invention therefore utilize number densities of protrusions of at least about 75, more preferably at least about 100, and most preferably at least about 200. With the adhesive system unitarily formed with the backsheet, backsheet materials of about 0.0005" to about 0.005" (one-half to 5 mils), preferably about 0.001" (1 mil), are presently preferred for use as an adhesive system substrate. Considering both the number density of protrusions and the unformed sheet material caliper, both of which are important in determining both the flexibility and breathability of the adhesive system and hence the absorbent article, these parameters can be represented in terms of a "flexibility factor" F calculated by dividing the number density N by the unformed material caliper C to arrive at the expression $F = (N/C)$, where the same dimensional units of measure are utilized in both N and C (i.e., number of protrusions per square inch and caliper in inches). Accordingly, in the context of the present invention, flexibility factors F of at least about 15,000, preferably at least about 75,000, more preferably at least about 100,000, and even greater than 150,000, 200,000, or 500,000 are believed to provide highly advantageous adhesive systems.

The number densities and flexibility factors of the adhesive systems of the present invention, by providing a flexible, conformable structure formed from a comparatively thin material, in turn provide for enhanced breathability in an adhesive-coated structure. On a comparable material basis, typically the thinner the material utilized the higher the breathability exhibited. Likewise, the more unobstructed surface area per unit of projected area of the backsheet, the higher the breathability exhibited. At the same time, the continuous network of adhesive provides for secure fastening of the central portion of the article and/or the flaps while maintaining breathability in these areas, particularly in the central portion. Flexibility is also particularly advantageous for the flaps, which are

required to fold around the side edges of the undergarment in use and yet exhibit sufficient adhesion to be effective.

The disclosures of all patents, patent applications (and any patents which issue thereon, as well as any corresponding published foreign patent applications), and publications mentioned throughout this patent application are hereby incorporated by reference herein. It is expressly not admitted, however, that any of the documents incorporated by reference herein teach or disclose the present invention. It is also expressly not admitted that any of the commercially available materials or products described herein teach or disclose the present invention.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention.

CLAIMS

1. An absorbent article having a body-facing side and a garment-facing side, said absorbent article comprising:
- 5 (a) a liquid pervious topsheet defining said body-facing side of said absorbent article;
- (b) a liquid impervious backsheet joined to said topsheet and defining said garment-facing side of said absorbent article;
- (c) an absorbent layer being positioned between said topsheet and said backsheet; and
- (d) an adhesive system located on said backsheet, said adhesive system comprising a
- 10 plurality of three-dimensional protrusions which are deformable into a substantially two-dimensional configuration and an interconnected network of adhesive surrounding said protrusions which is protected from inadvertent contact with external surfaces until said three-dimensional protrusions are deformed into said substantially two-
- dimensional configuration, said adhesive system having a number density of protrusions
- 15 greater than about 75 per square inch and a flexibility factor of at least about 15,000.
2. The absorbent article of Claim 1, wherein said adhesive system is unitarily formed with said backsheet.
- 20 3. The absorbent article of claim 1, wherein said absorbent article further includes a pair of flaps.
4. The absorbent article of claim 3, wherein said flaps include said adhesive system.

5. The absorbent article of claim 1, wherein said backsheet is formed from a breathable material.

6. The absorbent article of claim 1, wherein said backsheet is formed from a
5 microporous breathable material.

7. The absorbent article of claim 1, wherein said backsheet is formed from a monolithic breathable material.

10 8. The absorbent article of claim 1, wherein said adhesive system forms a plurality of separate zones on said backsheet.

9. The absorbent article of claim 1, wherein said adhesive is a pressure sensitive adhesive.

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10. The absorbent article of claim 1, wherein said absorbent article is selected from the group consisting of sanitary napkins, panty liners, incontinence devices, diapers, and bandages.

20 11. The absorbent article of claim 1, wherein said adhesive system has a number density greater than about 100 per square inch.

12. The absorbent article of claim 1, wherein said adhesive system has a flexibility factor greater than about 75,000.

13. The absorbent article of claim 1, wherein said adhesive system has a number density greater than about 200 per square inch.

5 14. The absorbent article of claim 1, wherein said adhesive system has a flexibility factor greater than about 100,000.

15. The absorbent article of claim 1, wherein said protrusions are conical.

10 16. The absorbent article of claim 1, wherein said adhesive system is linerless.

17. The absorbent article of claim 1, wherein said absorbent article is foldable.

18. An absorbent article having a body-facing side and a garment-facing side, said
15 absorbent article comprising:

(a) a liquid pervious topsheet defining said body-facing side of said absorbent article;

(b) a liquid impervious backsheet joined to said topsheet and defining said
garment-facing side of said absorbent article;

(c) an absorbent layer being positioned between said topsheet and said backsheet;

20 (d) a plurality of flaps extending outwardly from said backsheet; and

(e) an adhesive system located on said flaps, said adhesive system comprising a plurality of three-dimensional protrusions which are deformable into a substantially two-dimensional configuration and an interconnected network of adhesive surrounding said protrusions which is protected from inadvertent contact with external surfaces until

said three-dimensional protrusions are deformed into said substantially two-dimensional configuration, said adhesive system having a number density of protrusions greater than about 75 per square inch and a flexibility factor of at least about 15,000.

5 19. An absorbent article having a body-facing side and a garment-facing side, said absorbent article comprising:

(a) a liquid pervious topsheet defining said body-facing side of said absorbent article;

(b) a liquid impervious backsheet joined to said topsheet and defining said garment-facing side of said absorbent article;

10 (c) an absorbent layer being positioned between said topsheet and said backsheet;

(d) a plurality of flaps extending outwardly from said backsheet; and

(e) an adhesive system located on at least one of said backsheet and said plurality of flaps, said adhesive system comprising a plurality of three-dimensional protrusions which are deformable into a substantially two-dimensional configuration and an

15 interconnected network of adhesive surrounding said protrusions which is protected from inadvertent contact with external surfaces until said three-dimensional protrusions are deformed into said substantially two-dimensional configuration, said adhesive system having a number density of protrusions greater than about 75 per square inch and a flexibility factor greater than about 15,000.