10/012698 U.S. 11/05/01

U.S. UTILITY Patent Application

ISSUE DATE

APPL NUM	FILING DATE	CLASS	SUBCLASS	GAU	EXAMINER
10012698	11/05/2001	428 442	327	1771	Salvatore

APPLICANTS: Eaton Bradley; Jackson Byron; Wood Leigh; Tuman Scott;

BEST AVAILABLE COPY

CONTINUING DATA VERIFIED:

FOREIGN APPLICATIONS VERIFIED:

PG-PUB | DO NOT PUBLISH ☐ | RESCIND ☐

Foreign priority claimed ☐ yes ☒ no
35 USC 119 conditions met ☐ yes ☒ no
Verified and Acknowledged Examiners's Initials

ATTORNEY DOCKET NO
57190US002

TITLE: Composite webs with reinforcing polymeric regions and elastic polymeric regions

U.S DEPT. OF COMM./PAT.& TM-PTO-436L(Rev. 12-94)

NOTICE OF ALLOWANCE MAILED		CLAIMS ALLOWED	
6-26-03	Assistant Examiner	Total Claims: 16	Print Claim for O.G.: 1

ISSUE FEE			DRAWING		
Amount Due: $1600.00	Date Paid	TERREL MORRIS SUPERVISORY PATENT EXAMINER TECHNOLOGY CENTER 1700 Primary Examiner	Sheets Drwg.: 14	Figs.Drwg.: 31	Print Fig.: 1

☒ TERMINAL DISCLAIMER

PREPARED FOR ISSUE

Application Examiner

WARNING: The information disclosed herein may be restricted. Unauthorized disclosure may be prohibited by the United States Code Title 35 Sections 122, 181 and 368. Possession outside the U.S. Patent & Trademark Office is restricted to authorized employees and contractors only.

FILED WITH: ☐ DISK (CRF) ☐ CD-ROM

BEST AVAILABLE COPY

SEARCH

Class	Sub.	Date	Exmr.
442	327, 59 66	06/10/03	[illegible]
428	196, 198 411.1, 100	↓	↓

SEARCH NOTES

(List databases searched. Attach search strategy inside.)

	Date	Exmr.
East text search Consulted Terrel Morris	06/10/03	[illegible]

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
428	196, 198 411.1 100	06/10/03	[illegible]

ORIGINAL		CROSS REFERENCE(S)							
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)						
442	327	442	66	67					
INTERNATIONAL CLASSIFICATION		442	327	59					
		428	100	196	198	411.1			
B32B	3 100								
B32B	27 104								
B32B	27 112								
B32B	5 102								
B32B	9 104								

∧ Continued on Issue Slip Inside File Jacket

INDEX OF CLAIMS

✓ .... Rejected — (Through numeral) ... Canceled N .... Non-elected A .... Appeal
= .... Allowed + ... Restricted I .... Interference O .... Objected

Claim Final	Claim Original	Date 06/10/03	Claim Final	Claim Original	Date	Claim Final	Claim Original	Date
1	1	=		51			101	
2	2			52			102	
3	3			53			103	
4	4			54			104	
5	5			55			105	
6	6			56			106	
7	7			57			107	
8	8			58			108	
9	9			59			109	
10	10			60			110	
11	11	✓		61			111	
	12	—		62			112	
	13			63			113	
	14			64			114	
	15			65			115	
	16			66			116	
	17			67			117	
	18			68			118	
	19			69			119	
	20			70			120	
	21	✓		71			121	
12	22	=		72			122	
13	23			73			123	
14	24			74			124	
15	25			75			125	
16	26	✓		76			126	
	27			77			127	
	28			78			128	
	29			79			129	
	30			80			130	
	31			81			131	
	32			82			132	
	33			83			133	
	34			84			134	
	35			85			135	
	36			86			136	
	37			87			137	
	38			88			138	
	39			89			139	
	40			90			140	
	41			91			141	
	42			92			142	
	43			93			143	
	44			94			144	
	45			95			145	
	46			96			146	
	47			97			147	

12-12-01

A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):

Docket No.: 57190US002

Title: COMPOSITE WEBS WITH REINFORCING POLYMERIC REGIONS AND ELASTIC POLYMERIC REGIONS

11/05/01 11059 U.S. PTO

j1036 U.S. PTO 10/012698 11/05/01

Assistant Commissioner for Patents
ATTN: Box **PATENT APPLICATION**
Washington, D.C. 20231

We are transmitting the following documents along with this Transmittal Sheet (which is submitted in triplicate):

_X_ UTILITY PATENT APPLICATION including:

- _X_ Specification (47 consecutively numbered pgs, including 26claims on 7 consecutively numbered pgs and a _1_ pg Abstract);
- _X_ Drawings (_31_ figures on _14_ sheets);
- __ A signed/unsigned Declaration and Power of Attorney (__ pgs).

__ Application Data Sheet (__ pgs).
_X_ An itemized return postcard.
__ An Assignment of the invention to __ and Recordation Form Cover Sheet.
__ A check in the amount of $40.00 to pay the Assignment Recording Fee.
__ A certified copy of a __ application, Serial No. __, filed _______, the right of priority of which is claimed under 35 U.S.C. §119.
__ Computer readable form of "Sequence Listing." Applicants state that the paper copy form of the "Sequence Listing" section of the present application, and the computer readable form submitted herewith, are the same.
__ Other:__.

FILING FEE HAS BEEN DEFERRED HEREWITH

MUETING, RAASCH & GEBHARDT, P.A.
Customer Number: 26813

By: [signature]
Name: Kevin W. Raasch
Reg. No.: 35,651
Direct Dial: 612-305-1218
Facsimile: 612-305-1228

CERTIFICATE UNDER 37 CFR §1.10:
"Express Mail" mailing label number: EL 888 272 688 US   Date of Deposit: November 5, 2001
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR §1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, **ATTN: Box PATENT APPLICATION**, Washington, D.C. 20231.

By: [signature]
Name: Rachel Gagliardi-Graban

(LARGE ENTITY TRANSMITTAL UNDER RULE 1.10)

COMPOSITE WEBS WITH REINFORCING POLYMERIC REGIONS AND ELASTIC POLYMERIC REGIONS

FIELD OF THE INVENTION

The present invention relates to composite webs that include reinforcing discrete polymeric regions and elastic discrete polymeric regions.

BACKGROUND

The manufacture of articles formed of webs that require some reinforcement to withstand forces experienced during use are known. In many cases, reinforcement is simply provided over the entire substrate or web. Such approaches can, however, add cost and weight to the web, as well as stiffness over the entire surface of the web - even in those areas that do not require reinforcement. Furthermore, reinforcing layers that are coextensive with the web may also reduce its breathability.

To address some of these issues, smaller pieces of reinforcing materials may be attached to a web or substrate in selected areas that require reinforcement. The handling and attachment of such discrete pieces can, however, be problematic, by potentially reducing throughput, causing waste (where the discrete pieces are not securely attached), requiring precise registration or location on the web, requiring the use of adhesives or other bonding agents, etc. The discrete pieces may also present relatively sharp that may be the source of irritation or discomfort. The irritation or discomfort can be exacerbated because the reinforcing pieces are typically located on the surface of the substrate.

In addition to reinforcing substrates or webs, it may also be desirable to manufacture articles that exhibit elasticity in addition to reinforcing regions. The manufacture of articles that exhibit elasticity, i.e., the ability to at least partially recover their original shape after moderate elongation, may be desired for a number of reasons. For example, elasticity may be useful in connection with fastening systems for items such as garments (e.g., diapers, training pants, gowns, etc.). Elasticity in garments can provide what may be referred to as dynamic fit, i.e., the ability to stretch and recover in response to movement by the wearer.

Elasticity may also be useful in connection with other applications. For example, some fasteners may provide more consistent attachment if the fastener is held in tension that can be supplied by stretching the fastener and relying on the recovery forces to provide the desired tension. In other instances, elasticity may allow for easy adjustment of the size or length of a fastener or other article.

Although elasticity may be beneficial in a variety of different applications, it may raise issues in manufacturing. Many attempts to provide elasticity rely on separate elastic components that are, e.g., glued or sewn to a backing or other nonelastic member to provide the desired elasticity. The manufacture of such composite articles may be problematic in that secure attachment of the elastic components may be difficult to achieve and/or maintain. Further, the cost and difficulty of providing and attaching separate elastic components may be relatively high. The handling and attachment of separate elastic components can reduce throughput, cause additional waste (where the separate components are not securely attached), etc.

In other instances, an entire article may be constructed to provide the desired elasticity. For example, many elastic fastening systems rely on the use of elastic laminate backings in which the elastic materials are provided in the form of a film that is coextensive with the backing. Such an approach may add costs associated with providing a coextensive elastic layer or layers. Further, many elastic materials are not breathable. If the elastic laminate backings are to be used in garments, it may be desirable to perforate the backing to improve its breathability. Such additional processing does, however, add to the cost of producing the elastic laminate backing. Another potential disadvantage of elastic laminate backings is that it may be difficult to provide any variability in the elastic recovery forces generated in different portions of the backing.

SUMMARY OF THE INVENTION

The present invention provides methods of manufacturing composite webs including a substrate with one or more reinforcing discrete polymeric regions located on or within the composite web and one or more discrete elastic polymeric regions located on or within the composite web.

One advantage of the methods of the present invention is the ability to transfer one or more discrete polymeric regions onto a major surface of a substrate, where the thermoplastic material of the discrete polymeric region can be forced against the substrate by a transfer roll. If the substrate is porous, fibrous, etc., pressure may enhance attachment of the discrete polymeric regions to the substrates by forcing a portion of the thermoplastic composition to infiltrate the substrate and/or encapsulate fibers of the substrate.

Another advantage is the ability to control the shape, spacing, and volume of the discrete polymeric regions. This may be particularly advantageous because these parameters (shape, spacing, and volume) can be fixed regardless of the line speed of the system.

Another advantage of the present invention may be found in the composite depressions and their use, which may improve the formation of reinforcing discrete polymeric regions in accordance with the present invention. The composite depressions may, e.g., improve the transfer of relatively large discrete polymeric regions onto the substrates as well as the transfer of discrete polymeric regions that have a varying thickness.

Another advantage of the methods of the present invention is the ability to provide one or more discrete polymeric regions that extend for the length of the substrate (while not being formed over the width of the substrate, i.e., the discrete polymeric regions are not coextensive with the major surface of the substrate).

Another advantage of the methods of the present invention is the ability to provide different thermoplastic compositions across the width of the substrate, such that some discrete polymeric regions may be formed of one thermoplastic composition, while other discrete polymeric regions are formed of a different thermoplastic composition.

Yet another advantage of the methods of the present invention is the ability to provide one or more discrete polymeric regions on both major surfaces of a substrate. The discrete polymeric regions on the opposing major surfaces may be formed with the same or different features as desired.

In one aspect, the present invention provides an elastic article including a substrate with first and second major surfaces; one or more reinforcing discrete polymeric regions attached to the substrate, wherein each reinforcing discrete polymeric region of the one or more reinforcing discrete polymeric regions is formed of a nonelastomeric thermoplastic composition that infiltrates a portion of substrate; and one or more elastic elements attached to the substrate, wherein each elastic element of the one or more elastic elements includes an elastic discrete polymeric region formed of an elastomeric thermoplastic composition that infiltrates a portion of the substrate.

In another aspect, the present invention provides a method for producing a composite web by providing a first substrate having a first major surface and a second major surface, wherein a plurality of discrete elastomeric polymeric regions formed of an elastomeric thermoplastic composition are located on the first major surface of the first substrate, wherein each discrete elastomeric polymeric region of the plurality of discrete elastomeric polymeric regions infiltrates the first major surface of the first substrate. The method further includes providing a second substrate having a first major surface and a second major surface, a plurality of discrete nonelastomeric polymeric regions formed of a nonelastomeric thermoplastic composition located on the first major surface of the second substrate, wherein each discrete nonelastomeric polymeric region of the plurality of discrete nonelastomeric polymeric regions infiltrates the first major surface of the second substrate; and laminating the first substrate to the second substrate.

In another aspect, the present invention provides a method for producing a composite web by providing a substrate with a first major surface and a second major surface; and forming a plurality of discrete elastomeric polymeric regions formed of an elastomeric thermoplastic composition on the first major surface of the substrate, wherein each discrete elastomeric polymeric region of the plurality of discrete elastomeric polymeric regions infiltrates the first major surface of the substrate. The method further includes forming a plurality of discrete nonelastomeric polymeric regions formed of a nonelastomeric thermoplastic composition located on the first major surface or the second major surface of the substrate, wherein each discrete nonelastomeric polymeric region of the plurality of discrete nonelastomeric polymeric regions infiltrates the second substrate.

In another aspect, the present invention provides a composite web that includes a substrate with first and second major surfaces; a plurality of nonelastomeric discrete polymeric regions attached to the substrate, wherein each nonelastomeric discrete polymeric region of the plurality of nonelastomeric discrete polymeric regions is formed of a nonelastomeric thermoplastic composition that infiltrates a portion of substrate; a plurality of elastomeric discrete polymeric regions attached to the substrate, wherein each elastomeric discrete polymeric region of the plurality of elastomeric discrete polymeric regions is formed of an elastomeric thermoplastic composition that infiltrates a portion of the substrate; and one or more lines of separation in the substrate. The one or more lines of separation define boundaries of a plurality of distinct articles in the composite web, and wherein each article of the plurality of articles includes at least one nonelastomeric discrete polymeric region of the plurality of nonelastomeric discrete polymeric regions and at least one elastomeric discrete polymeric region of the plurality of elastomeric discrete polymeric regions.

These and other features and advantages of methods according to the present invention are described below in connection with various illustrative embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of one reinforcing discrete polymeric region on a composite web manufactured according to the methods of the present invention.

FIG. 2 is a plan view of a portion of a transfer roll that can be used in manufacturing composite webs according to the methods of the present invention.

FIG. 3A is a cross-sectional view of the depression of FIG. 2, taken along line 3-3 in FIG. 2 at one point during formation of the depression.

FIG. 3B is a cross-sectional view of the depression of FIG. 2, taken along line 3-3 in FIG. 2 at another point during formation of the depression.

FIG. 3C is a cross-sectional view of the depression of FIG. 2, taken along line 3-3 in FIG. 2 during formation of the depression.

FIG. 4 is a plan view of another depression on a portion of a transfer roll that can be used to manufacture reinforcing discrete polymeric regions on a composite web according to the methods of the present invention.

FIG. 5 is a cross-sectional view of the depression of FIG. 4, taken along line 5-5 in FIG. 4.

FIG. 6 is a plan view of another depression on a portion of a transfer roll that can be used to manufacture reinforcing discrete polymeric regions on a composite web according to the methods of the present invention.

FIG. 7 is a cross-sectional view of a composite web manufactured according to the methods of the present invention including reinforcing discrete polymeric regions between two substrates.

FIG. 8 is a cross-sectional view of the composite web of FIG. 7, before attachment of the two substrates to form the composite web in accordance with the methods of the present invention.

FIG. 9 is a plan view of one illustrative substrate with reinforcing discrete polymeric regions formed thereon that can be manufactured into a composite web according to the methods of the present invention.

FIG. 10 is a cross-sectional view of another composite web with reinforcing discrete polymeric regions on both major surfaces of a substrate.

FIG. 11 is a perspective view of one polymer transfer process useful in providing discrete polymeric regions on a substrate in accordance with the methods of the present invention.

FIG. 11A is an enlarged schematic diagram depicting the relationship between a doctor blade and a depression on a transfer roll used in connection with the present invention.

FIG. 11B is an enlarged partial cross-sectional view depicting a conformable backup roll forcing a substrate against a transfer roll.

FIG. 11C is an enlarged partial cross-sectional view depicting a mating backup roll including protrusions aligned with depressions in the transfer roll.

FIG. 12 illustrates another transfer roll and polymer source useful in connection with zoned delivery systems and methods.

FIG. 13 is a plan view of one article formed in a composite web by providing reinforcing discrete polymeric regions on a substrate according to the methods of the present invention.

FIG. 14 is a cross-sectional view of the article of FIG. 13 taken along line 14-14 in FIG. 13.

FIG. 15 is a plan view of a portion of one composite web manufactured according to the present invention.

FIG. 16 is a perspective view of one transfer roll that may be used to manufacture the composite web of FIG. 15.

FIG. 17 is a plan view of a portion of one composite web manufactured according to the present invention that includes discrete polymeric regions extending across the width of the substrate.

FIG. 18 is a plan view of one article manufactured from a composite web including elastomeric and nonelastomeric discrete polymeric regions.

FIG. 19 is a cross-sectional view of the article of FIG. 18, taken along line 19-19 in FIG. 18.

FIG. 20 is a cross-sectional view of an article manufactured from a laminated composite web including elastomeric and nonelastomeric discrete polymeric regions.

FIG. 21 is a plan view of another article manufactured from a composite web including elastomeric and nonelastomeric discrete polymeric regions.

FIG. 22 is a cross-sectional view of the article of FIG. 21, taken along line 22-22 in FIG. 21.

FIG. 23 is a cross-sectional view of the article of FIG. 21, taken along line 23-23 in FIG. 21.

FIG. 24 is a plan view of one composite web according to the present invention, the composite web including lines of separation formed therein.

FIG. 25 is a schematic diagram of one system and method for manufacturing composite webs according to the present invention.

FIG. 26 is a schematic diagram of another system and method for manufacturing composite webs according to the present invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS OF THE INVENTION

As discussed above, the present invention provides methods and systems for producing composite webs that include a substrate with reinforcing discrete polymeric regions located on the surface or within the composite web. Various different constructions will now be described to illustrate various embodiments of the composite webs that can be manufactured in accordance with the methods of the present invention. These illustrative constructions should not be considered to limit the methods of the present invention, which is to be limited only by the claims that follow.

FIG. 1 is a cross-sectional view of a portion of one composite web manufactured in accordance with the present invention. The composite web includes a substrate 10 with a first major surface 18 and a second major surface 19. One or more reinforcing discrete polymeric regions 14 are located on the first major surface 18 of the substrate 10, it being understood that the substrate may include more than one reinforcing discrete polymeric region as depicted in, e.g., FIGS. 7-12.

It may be preferred that the reinforcing discrete polymeric regions 14 of composite webs manufactured in accordance with the present invention each include a varying thickness or height above the surface 18 of the substrate 10. It may be particularly preferred that the thickness variations be provided in the form of a thinner discrete polymeric region proximate the edges 15 of the reinforcing discrete polymeric region 14.

The combination of thicker central portions of the reinforcing discrete polymeric region 14 and thinner edges 15 may provide advantages. The thinner edges 15 may be more flexible or softer, which may enhance comfort if the composite web including such discrete polymeric regions is incorporated into a garment such as, e.g., a diaper, surgical gown, etc. At the same time, the thicker central portion of the reinforcing discrete polymeric region 14 may provide a desired level of rigidity to the discrete polymeric region.

The reinforcing discrete polymeric regions 14 may cover any desired portion of the surface 18 of the substrate 10 on which they are positioned, although it will be understood that the discrete polymeric regions 14 will not cover all of the surface of the substrate 10. Some variations in the percentage of surface area occupied by discrete polymeric regions may be as described in, for example, pending U.S. Patent Application Serial No. 09/257,447, entitled WEB HAVING DISCRETE STEM REGIONS, filed on Feb. 25, 1999 (published as International Publication No. WO 00/50229).

Further, although the discrete polymeric regions 14 are depicted as being disconnected from each other, it should be understood that some composite webs manufactured with the systems and methods of the present invention may include a relatively thin skin layer of the thermoplastic composition used to form the discrete polymeric regions. Such a skin layer may, in some instances, connect some or all of the discrete polymeric regions on the composite web. In any event, however, the amount of polymeric material in the skin layer will be insufficient to provide significant reinforcement of the substrate outside of the thicker discrete polymeric regions. If the composite web includes elastomeric discrete polymeric regions as discussed in connection with FIGS. 18-26, the amount of elastomeric polymeric material in any elastomeric skin layer will be insufficient to provide significant elasticity to the substrate outside of the thicker elastomeric discrete polymeric regions.

The substrates used in connection with the composite webs of the present invention may have a variety of constructions. For example, the substrates may be a woven material, nonwoven material, knit material, paper, film, or any other continuous media that can be fed through a nip point. The substrates may have a wide variety of properties, such as extensibility, elasticity, flexibility, conformability, breathability, porosity, stiffness, etc. Further, the substrates may include pleats, corrugations or other deformations from a flat planar sheet configuration.

In some instances, the substrates may exhibit some level of extensibility and also, in some instances, elasticity. Extensible webs that may be preferred may have an initial yield tensile force of at least about 50 gm/cm, preferably at least about 100 gm/cm. Further, the extensible webs may preferably be extensible nonwoven webs.

Suitable processes for making a nonwoven web that may be used in connection with the present invention include, but are not limited to, airlaying, spunbond, spunlace, bonded melt blown webs and bonded carded web formation processes. Spunbond nonwoven webs are made by extruding a molten thermoplastic, as filaments from a series of fine die orifices in a spinneret. The diameter of the extruded filaments is rapidly reduced under tension by, for example, by non-eductive or eductive fluid-drawing or other known spunbond mechanisms, such as described in U.S. Patent Nos. 4, 340,563 (Appel et al.); 3,692,618 (Dorschner et al.); 3,338,992 and 3,341,394 (Kinney); 3,276,944 (Levy); 3,502,538 (Peterson); 3,502,763 (Hartman) and 3,542,615 (Dobo et al.). The spunbond web is preferably bonded (point or continuous bonding).

The nonwoven web layer may also be made from bonded carded webs. Carded webs are made from separated staple fibers, which fibers are sent through a combing or carding unit which separates and aligns the staple fibers in the machine direction so as to form a generally machine direction-oriented fibrous nonwoven web. However, randomizers can be used to reduce this machine direction orientation.

Once the carded web has been formed, it is then bonded by one or more of several bonding methods to give it suitable tensile properties. One bonding method is powder bonding wherein a powdered adhesive is distributed through the web and then activated, usually by heating the web and adhesive with hot air. Another bonding method is pattern bonding wherein heated calender rolls or ultrasonic bonding equipment are used to bond the fibers together, usually in a localized bond pattern though the web can be bonded across its entire surface if so desired. Generally, the more the fibers of a web are bonded together, the greater the nonwoven web tensile properties.

Airlaying is another process by which fibrous nonwoven webs useful in the present invention can be made. In the airlaying process, bundles of small fibers usually having lengths ranging between about 6 to about 19 millimeters are separated and entrained in an air supply and then deposited onto a forming screen, often with the assistance of a vacuum supply. The randomly deposited fibers are then bonded to one another using, for example, hot air or a spray adhesive.

Meltblown nonwoven webs may be formed by extrusion of thermoplastic polymers from multiple die orifices, which polymer melt streams are immediately attenuated by hot high velocity air or steam along two faces of the die immediately at the location where the polymer exits from the die orifices. The resulting fibers are entangled into a coherent web in the resulting turbulent airstream prior to collection on a collecting surface. Generally, to provide sufficient integrity and strength for the present invention, meltblown webs must be further bonded such as by through air bonding, heat or ultrasonic bonding as described above.

A web can be made extensible by skip slitting as is disclosed in, e.g., International Publication No. WO 96/10481 (Abuto et al.). If an elastic, extensible web is desired, the slits are discontinuous and are generally cut on the web prior to the web being attached to any elastic component. Although more difficult, it is also possible to create slits in the nonelastic web layer after the nonelastic web is laminated to the elastic web. At least a portion of the slits in the nonelastic web should be generally perpendicular (or have a substantial perpendicular vector) to the intended direction of extensibility or elasticity (the at least first direction) of the elastic web layer. By generally perpendicular it is meant that the angle between the longitudinal axis of the chosen slit or slits and the direction of extensibility is between 60 and 120 degrees. A sufficient number of the described slits are generally perpendicular such that the overall laminate is elastic. The provision of slits in two directions is advantageous when the elastic laminate is intended to be elastic in at least two different directions.

A nonwoven web used in connection with the present invention can also be a necked or reversibly necked nonwoven web as described in U.S. Patent Nos. 4,965,122; 4,981,747; 5,114,781; 5,116,662; and 5,226,992 (all to Morman). In these embodiments the nonwoven web is elongated in a direction perpendicular to the desired direction of extensibility. When the nonwoven web is set in this elongated condition, it will have stretch and recovery properties in the direction of extensibility.

The substrates used in connection with the present invention may preferably exhibit some porosity on one or both of the major surfaces of the substrate such that when a molten thermoplastic composition is provided on one of the major surfaces of the substrate, a mechanical bond is formed between the molten thermoplastic composition and the substrate as the molten thermoplastic composition infiltrates and/or encapsulates a portion of the porous surface of the substrate. As used in connection with the present invention, the term "porous" includes both structures that include voids formed therein, as well as structures formed of a collection of fibers (e.g., woven, nonwoven, knit, etc.) that allow for the infiltration of molten thermoplastic composition into the interstices between fibers. If the porous surface includes fibers, the thermoplastic composition may preferably encapsulate fibers or portions of fibers on the surface of the substrate.

The type and construction of the material or materials in the substrate should be considered when selecting an appropriate substrate to which a molten thermoplastic composition is applied. Generally, such materials are of the type and construction that do not melt, soften, or otherwise disintegrate under the temperatures and pressures experienced during the step of transferring the thermoplastic composition to the substrate. For example, the substrate should have sufficient internal strength such that it does not fall apart during the process. Preferably, the substrate has sufficient strength in the machine direction at the temperature of the transfer roll to remove it intact from the transfer roll.

As used herein, the term "fiber" includes fibers of indefinite length (e.g., filaments) and fibers of discrete length, e.g., staple fibers. The fibers used in connection with the present invention may be multicomponent fibers. The term "multicomponent fiber" refers to a fiber having at least two distinct longitudinally coextensive structured polymer domains in the fiber cross-section, as opposed to blends where the domains tend to be dispersed, random, or unstructured. The distinct domains may thus be formed of polymers from different polymer classes (e.g., nylon and polypropylene) or be formed of polymers from the same polymer class (e.g., nylon) but which differ in their properties or characteristics. The term "multicomponent fiber" is thus intended to include, but is not limited to, concentric and eccentric sheath-core fiber structures, symmetric and asymmetric side-by-side fiber structures, island-in-sea fiber structures, pie wedge fiber structures, and hollow fibers of these configurations.

Although the substrates depicted in the various cross-sectional views of the articles manufactured according to the methods of the present invention are illustrated as single layer structures, it should be understood that the substrates may be of single or multi-layer construction. If a multi-layer construction is used, it will be understood that the various layers may have the same or different properties, constructions, etc. Some of these variations may be as described in, for example, pending U.S. Patent Application Serial No. 09/257,447, entitled WEB HAVING DISCRETE STEM REGIONS, filed on Feb. 25, 1999 (published as International Publication No. WO 00/50229).

The discrete polymeric regions 14 may be formed of a wide variety of different nonelastomeric thermoplastic polymeric materials. As used in connection with the present invention, "thermoplastic" (and variations thereof) means a polymer or polymeric composition that softens when exposed to heat and returns to its original condition or near its original condition when cooled to room temperature. The thermoplastic compositions used in connection with the methods of the present invention should be capable of flowing or entering into depressions formed in a polymer transfer roll as will be described below.

Suitable thermoplastic compositions are those that are melt processable. Such polymers are those that will flow sufficiently to at least partially fill the depressions, yet not significantly degrade during a melt process. A wide variety of thermoplastic compositions have suitable melt and flow characteristics for use in the process of the present invention depending on the geometry of the depressions and the processing conditions. It may further be preferred that the melt processable materials and conditions of processing are selected such that any viscoelastic recovery properties of the thermoplastic compositions do not cause them to significantly withdraw from the wall(s) of the depressions until transfer of the thermoplastic composition to a substrate is desired.

Some examples of nonelastomeric thermoplastic compositions that may be used in connection with the present invention include, but are not limited to, polyurethanes, polyolefins (e.g., polypropylenes, polyethylenes, etc.), polystyrenes, polycarbonates, polyesters, polymethacrylates, ethylene vinyl acetate copolymers, ethylene vinyl alcohol copolymers, polyvinylchlorides, acrylate modified ethylene vinyl acetate polymers, ethylene acrylic acid copolymers, nylons, fluorocarbons, etc.

A nonelastomeric thermoplastic polymer is one that melts and returns to its original condition or near its original condition upon cooling and which does not exhibit elastomeric properties at ambient conditions (e.g., room temperature and pressure). As used in connection with the present invention, "nonelastomeric" means that the material will not substantially resume its original shape after being stretched. Further, the nonelastomeric materials may preferably sustain permanent set following deformation and relaxation, which set is preferably at least about 20 percent or more, and more preferably at least about 30 percent or more of the original length at moderate elongation, e.g., about 50% (for those materials that can even be stretched up to 50% without fracture or other failure).

The nonelastomeric thermoplastic compositions used in connection with the present invention can also be combined with various additives for desired effect. These include, for example, fillers, viscosity reducing agents, plasticizers, tackifiers, colorants (e.g., dyes or pigments), antioxidants, antistatic agents, bonding aids, antiblocking agents, slip agents, stabilizers (e.g., thermal and ultraviolet), foaming agents, microspheres, glass bubbles, reinforcing fibers (e.g., microfibers), internal release agents, thermally conductive particles, electrically conductive particles, and the like. The amounts of such materials that can be useful in the thermoplastic compositions can be readily determined by those skilled in the art of processing and using such materials.

FIG. 2 is a plan view of a portion of the exterior surface of one transfer tool that can be used to deposit the reinforcing discrete polymeric region 14 on the substrate 10 depicted in Figure 1. That depicted portion of the exterior surface 32 includes a depression 34 formed therein. FIG. 2 also depicts a number of smaller depressions 38 dispersed over the surface 32 of the transfer roll. Each of the depressions 38 is smaller than the larger depression 34, both in terms of footprint (see below) as well as depression volume. The smaller depressions 38 may also fill with molten thermoplastic composition during use of the transfer roll, with the smaller discrete polymeric regions formed by the depressions 38 serving a variety of purposes as discussed in connection with FIGS. 7-9 below.

The depression 34 is preferably a composite of cells 34a, 34b, 34c and 34d formed in the surface 32 by any suitable technique, e.g., machining, etching, laser ablation, etc. FIGS. 3A-3C depict one set of steps that can be used to manufacture a composite depression 34 in the transfer roll 30 as seen in FIG. 2. The views in FIGS. 3A-3C are taken along line 3-3 in FIG. 2 and, as a result, do not include the smallest cells 34d seen in FIG. 2.

Further, the complete outline of each of the cells is depicted in FIG. 2 for a better understanding of the invention, although it will be understood that portions of each of the cells may not actually be visible in the finished composite depression 34. In addition, the depicted composite depression 34 is made of a multiple circular cells 34a-34d. It should, however, be understood that composite depressions according to the present invention may be made of cells having any selected shape, e.g., oval, square, triangular, etc. Further, the composite depressions of the present invention may be constructed of cells having a variety of shapes and/or sizes.

In the depicted composite depression 34, cells 34a have the largest diameter and are formed to the greatest depth into the surface 32. Further, the cells 34a may be formed first as seen in FIG. 3A. Alternatively, the smaller cells may be formed first, with the larger cells formed later. The cells 34b may be formed next as depicted in FIG. 3B. Cells 34b are, in the depicted embodiment, formed to a shallower depth in the transfer roll 30 than cell 34a. It can be seen there that the cells 34b overlap the larger cell 34a, such that not all of the outline of the smaller cells 34b is actually formed into the transfer roll 30.

The final step depicted in FIG. 3C is the formation of smaller cells 34c farther outward from the central cell 34a than cells 34b. In the depicted embodiment, these outer cells 34c are formed to a shallower depth than cells 34b, thereby contributing to the general thinning at the edges of a reinforcing discrete polymeric region as seen in, e.g., FIG. 1.

Although not wishing to be bound by any theory, it is hypothesized that the features (e.g., edges, ridges, etc.) formed at the boundaries between the various cells in the composite structure of depression 34 may enhance its ability to retain molten thermoplastic composition during the transfer process as discussed below.

The depressions on transfer rolls used in connection with the present invention may be characterized in terms of the area occupied by their footprint on the exterior surface of the forming tool, a maximum dimension of the footprint (in any direction on the surface of the roll), the volume of the depression, the shape of the footprint, etc.

When characterized in terms of the area occupied by the footprint of the depressions, each of the depressions 34 may have a footprint with an area of about 4 square millimeters (mm^2) or more. In other situations, each of the depressions 34 may have footprints with an area of about 8 mm^2 or more.

Another manner in which the depressions may be characterized is in terms of the largest footprint dimension as measured on the surface 32 of the transfer roll 30. When characterized in terms of the largest footprint dimension of the footprint, it may be that the depressions have a largest footprint dimension of about 2 mm or more, in some instances about 5 mm or more.

Yet another manner in which the depressions used in connection with the present invention may be characterized is in terms of depression volume. For example, the depressions may have a depression volume of at least about three (3) cubic millimeters (mm^3) or more, or alternatively a depression volume of about five (5) cubic millimeters or more. Volume may be important because at least some of the molten thermoplastic composition may be retained within the depression during the transfer process, i.e., the depression volume may preferably be oversized relative to the preferred volume of the discrete polymeric regions to be formed by the depressions to compensate for retention of thermoplastic composition within the depressions.

The orientation of the depression 34 on a transfer roll 30 may be selected based on a variety of factors. The elongated depression 34 may be aligned in the machine direction (i.e., the direction of travel of a substrate), in the cross-web direction (i.e., transverse to the direction of travel of the substrate), or any other orientation between machine direction or cross-web direction.

FIGS. 4 and 5 depict yet another variation in the shape of depressions formed in transfer tools used to provide reinforcing discrete polymeric regions on substrates in connection with the methods of the present invention. The depression 134 is located in the surface 132 of a transfer tool in the shape of a circular trough with an island 133 located in the center of depression 134 formed in the exterior surface 132.

Depressions that include islands such as that depicted in FIG. 4 can be used to provide reinforcing discrete polymeric regions on a substrate in which a portion of the substrate is exposed within a surrounding ring of polymer. The resulting construction may, for example, be used to reinforce the substrate in the area of, e.g., a buttonhole, slot, perforation, or other opening formed on in the substrate. Other uses for similar structures may also be envisioned.

The island 133 formed in the center of depression 134 is preferably the same height as the exterior surface 132 of the transfer roll that surrounds the depression 134. Although the depression 134 is depicted with only a single island 133 formed therein, depressions used in connection with the methods of the present invention may include two or more islands located within each depression if so desired. Furthermore, the shape of the island and surrounding depression may also vary, e.g., a depression that has a circular outermost perimeter may be paired with an island having a different shape. In another variation, the island may not be centered within the depression as depicted in FIG. 4.

Another variation depicted in FIG. 5 is the variation in depth of the depression 134, with the depression being deepest proximate the island and rising to a shallower depth at the outermost perimeter of the depression 134. Such a construction may provide a reinforcing discrete polymeric region with more flexible edges due to thinning of the polymeric region as discussed above in connection with FIG. 1. Further, although the depression 134 is not depicted as having a composite construction as does depression 34 in FIG. 2, the depression 134 including island 133 may advantageously be formed as a composite depression of multiple cells.

FIG. 6 depicts another depression 234 formed in the surface 232 of a transfer tool, with the depression 234 also including an island 233 in a manner similar to the depression 134 of FIGS. 4 and 5. Unlike depression 134, the depression 234 is elongated in a generally oval shape that may be more conducive to the formation of a buttonhole or similar structure. Again, although the depression 234 is not depicted as having a composite construction as does depression 34 in FIG. 2, it may advantageously be formed as a composite depression of multiple cells.

FIGS. 7 and 8 depict yet another variation in a composite web manufactured according to the methods of the present invention. The composite web of FIG. 7 is a laminated structure including a first substrate 310a laminated to a second substrate 310b to form a laminated substrate 310. A number of discrete polymeric regions 314 are located between the two substrates 310a and 310b. A number of smaller discrete polymeric regions 380 are depicted as being located between the larger discrete polymeric regions 314. The smaller discrete polymeric regions 380 are optional, i.e., they may not be required in addition to the larger discrete polymeric regions 314. These smaller features may be helpful to attach the two substrates 310a and 310b together between the larger discrete polymeric regions 314.

In some instances, attachment of the two substrates 310a and 310b may be accomplished using the discrete polymeric regions 314 and 380 alone when the lamination is performed while the polymer regions 314 and 380 are still in a somewhat molten state such that they can bond with counterpart discrete polymeric regions on the opposing substrate or to the opposing substrate itself. One advantage of this construction is that the lamination may be accomplished without the need for additional materials and/or process steps. The lamination between substrates 310a and 310b may alternatively be assisted by a variety of materials and/or techniques known to those skilled in the art, e.g., thermal bonding, adhesives, resins, tie films/webs, etc. See, e.g., U.S. Patent Nos. 2,787,244 (Hickin); 3,694,867 (Stumpf); 4,906,492 (Groshens); 5,685,758 (Paul et al.); and 6,093,665 (Sayovitz et al.).

The laminated construction of FIG. 7 may be useful, for example, to provide a cloth-like or softer feel or appearance, breathability, porosity, etc. on both sides of the composite web. This is in contrast to the composite webs in which the discrete polymeric regions are located on an exposed surface of the composite web. A laminated composite web structure such as that seen in FIG. 7 may also be used to provide different properties on opposite sides of the composite web structure. For example, the porosity or other properties may differ between the different substrates 310a and 310b.

FIG. 8 depicts lamination of the substrates 310a and 310b by forces operating in the directions of the arrows located at both sides of the figure. One of the aspects depicted in FIG. 8 is the combination of discrete polymeric regions 314a on substrate 310a with discrete polymeric regions 314b located on the opposing surface of substrate 310b to form the discrete polymeric regions 314 in the composite web as depicted in FIG. 7.

Another aspect depicted in FIG. 8 is that the smaller polymeric regions 380 seen in FIG. 7 may be constructed from the combination of a polymeric region 380a on substrate 310a and a polymeric region 380b on substrate 310b. In other instances, the smaller polymeric region is located on only one of the substrates 310a or 310b and preferably bonds directly to the opposing substrate during lamination. Similarly, in some instances the larger discrete polymeric regions 314 may be formed by depositing polymer on only one of the substrates 310a or 310b before attaching the opposing substrate.

Another potential advantage of the laminated construction of the composite web seen in FIGS. 7 and 8 is that the reinforcing discrete polymeric regions 314 formed by laminating two separate polymeric regions 314a and 314b together may provide a combined reinforcing discrete polymeric region 314 that contains more polymer than could be effectively deposited as a single reinforcing discrete polymeric region using the methods of the present invention. That additional polymer may provide reinforcing discrete polymeric regions that are stiffer, thicker, or have other advantageous features.

FIG. 9 is a plan view of a composite web that may be used to form the composite web depicted in FIG. 7 in which two portions 310a and 310b of a single, unitary substrate 310 can be folded along a fold line 302 to provide the laminated structure of FIGS. 7 and 8. Alternatively, the substrates 310a and 310b as seen in, e.g., FIG. 8, may be separate from each other before lamination. The substrate 310 includes opposing reinforcing discrete polymeric regions 314a and 314b on portions 310a and 310b that are combined when the substrate 310 is folded along fold line 302.

The substrate 310 also includes a number of opposing smaller discrete polymeric regions 380a and 380b on portions 310a and 310b that are combined when the substrate 310 is folded along fold line 302. Further, the substrate 310 includes some smaller discrete polymeric regions 380a and 380b that do not oppose any similar deposits on the opposite side of the fold line 302.

Although the discrete polymeric regions 314a and 314b are shown as being uniformly spaced over the surface of the substrate 310 in a regular, repeating pattern (in both the x and y directions), it should be understood that spacing between the reinforcing discrete polymeric regions 314a and 314b may be non-uniform if so desired. Furthermore, the pattern in which the reinforcing discrete polymeric regions are arranged, may be irregular and/or non-repeating.

In other variations, portions of the composite webs manufactured in accordance with the present invention may include uniformly-spaced discrete polymeric regions as depicted in FIG. 9 while other portions of the same composite web may be free of any discrete polymeric regions. In yet another alternative, portions of the composite web manufactured in accordance with the present invention may include uniformly spaced discrete polymeric regions as seen in FIG. 9, while other portions of the same composite web may include discrete polymeric regions that are arranged in a non-uniform and/or non-repeating patterns. Further, different portions of a composite web manufactured according to the present invention may include different sets of discrete polymeric regions that are both uniformly spaced in repeating patterns that are different from each other.

The discrete polymeric regions could be provided in any desired shape, e.g., squares, rectangles, hexagons, etc. The shapes may or may not be in the form of recognized geometric shapes, but may be randomly formed with irregular perimeters. In addition, the shapes may not necessarily be solid figures, but may include islands formed within the shape in which none of the thermoplastic composition is transferred. In yet another alternative, some or all of the discrete polymeric regions may be in the form of indicia, i.e., letters, numbers, or other graphic symbols.

FIG. 10 illustrates yet another embodiment of a composite web manufactured in accordance with the present invention. The composite web includes a substrate 410 with opposing major surfaces 418 and 419. One feature illustrated in FIG. 10 is the two-sided nature of the reinforcing discrete polymeric regions located on the opposing major surfaces 418 and 419, respectively. Reinforcing discrete polymeric region 414 is provided on major surface 418 and reinforcing discrete polymeric region 424 is provided on opposing major surface 419. Both discrete polymeric region 414 and discrete polymeric region 424 are exposed on opposite sides of the composite web.

The discrete polymeric regions on opposing major surfaces are depicted as being in registration through the substrate 410. In other words, the discrete polymeric region 414 is aligned with the discrete polymeric region 424 on the opposite side of the substrate 410. Further, the discrete polymeric region 414 is depicted as being substantially the same size as the discrete polymeric region 424 located on the opposite side of the substrate 410. It should, however, be understood that when a composite web having discrete polymeric regions on both major surfaces is desired, the discrete polymeric regions on the opposing surfaces may or may not be the same size as seen in FIG. 10. Also, it should be understood that the discrete polymeric regions may or may not be in registration with each other through the substrate 410 as seen in FIG. 10.

The reinforcing discrete polymeric regions 414 and 424 may be envisioned as forming a grommet structure on the substrate 410. As a result, it may be desired to provide an optional opening 404 through the substrate 410 as seen in FIG. 10. The opening may be formed by any suitable technique, e.g., mechanical perforation with a tool, laser ablation, water or gas-jet cutting, etc. It will be understood that similar openings could be provided in, e.g., the laminated composite web seen in FIG. 7 as well.

FIG. 11 is a perspective view of one system and method of providing discrete polymeric regions on one surface of a substrate 10 in accordance with the principles of the present invention. The system depicted in FIG. 11 includes a substrate 10 that defines a web path through the system. The substrate 10 moves through the system in a downstream direction indicated by the rotation arrows on the various rolls. After being unwound or otherwise provided from a supply (e.g., the substrate 10 may be manufactured in-line with the system depicted in FIG. 11), the substrate 10 is directed into a transfer nip formed between a backup roll 20 and a transfer roll 30.

The process of providing discrete polymeric regions on the substrate 10 includes delivering a supply of a molten thermoplastic composition to the exterior surface 32 of transfer roll 30 that includes a one or more depressions 34 formed in its exterior surface 32. The molten thermoplastic composition 41 is supplied to the exterior surface 32 of the transfer roll 30 by a delivery apparatus in the form of a trough 40 (or other supply apparatus, e.g., extruder, gear pump, etc.).

The excess molten thermoplastic composition is wiped or removed from the exterior surface 32 by a doctor blade 42 acting against the exterior surface 32 of the transfer roll 30. Although it may be ideal to remove all of the thermoplastic composition from the exterior surface 32 of the transfer roll 30, some of the thermoplastic composition may remain on the exterior surface 32 after wiping by the doctor blade 42.

The depressions 34 formed in the exterior surface 32 of the transfer roll 30 preferably receive a portion of the molten thermoplastic composition when the molten thermoplastic composition is deposited on the exterior surface 32 of the transfer roll 30. If the depressions 34 are not completely filled during or by the deposition of molten thermoplastic composition, the wiping action of the doctor blade 42 on the exterior surface 32 of the transfer roll 30 may assist in substantially filling the depressions with molten thermoplastic composition.

Control over the temperatures of the various rolls in the system depicted in FIG. 11 may be useful in obtaining the desired products. It may be preferred, e.g., that the exterior surface 32 of the transfer roll 30 be heated to a selected temperature that is at or above the melt temperature of the thermoplastic composition to be transferred to the substrate 10. Heating the transfer roll 30 may also enhance filling of the depressions 34 by the molten thermoplastic composition.

Because the molten thermoplastic composition 41 is itself heated within the trough 40, the doctor blade 42 will typically be heated by the molten thermoplastic composition. It may alternatively be desirable to control the temperature of the doctor blade 42 separately from the trough 40 containing the molten thermoplastic composition 41. For example, it may be desirable to heat the doctor blade 42 to a temperature above the melt temperature of the molten thermoplastic composition.

FIG. 11A is an enlarged partial cross-sectional view depicting one relationship between a doctor blade 42 and depression 34 in a transfer roll 30. Another characteristic of the doctor blade 42 that may be controlled is its thickness or length 43 along the exterior surface of the transfer roll 30 (as measured in the machine direction or the direction of rotation of the transfer roll). For example, a thicker or longer doctor blade 42 may help by allowing the molten thermoplastic composition more time to relax within the depressions 34, thereby improving filling of the depressions. In addition to varying the length of the doctor blade 42, the pressure or force exerted on the transfer roll 30 by the doctor blade 42 may also be adjusted based on a variety of factors including, e.g., the characteristics of the molten thermoplastic composition, the transfer roll characteristics, etc.

With the depressions 34 at least partially filled with the desired molten thermoplastic composition, the transfer roll 30 continues to rotate until the depressions 34 and the molten thermoplastic composition they contain are forced into contact with the substrate 10 against backup roll 20 at the transfer nip (i.e., the nip formed by the transfer roll 30 and the backup roll 20. It is at this point that transfer of the molten thermoplastic composition in the depressions 34 to the substrate 10 begins. It should be understood that under certain conditions, only a portion of the thermoplastic composition in the depressions 34 may transfer to the substrate 10.

When a substrate 10 that includes one or more porous major surfaces on which the molten thermoplastic composition is deposited is used in connection with the methods of the present invention, a mechanical bond is preferably formed by infiltration of the molten thermoplastic composition into the porous surface of the substrate 10. As used in connection with the present invention, the term "porous" includes both structures that include voids formed therein, as well as structures formed of a collection of fibers (e.g., woven, nonwoven or knit) that allow for the penetration of molten thermoplastic compositions.

The nip pressure between the transfer roll 30 and the backup roll 20 is preferably sufficient such that a portion of the thermoplastic composition in the discrete polymeric regions infiltrates and/or encapsulates a portion of the porous substrate 10 to improve attachment of the discrete polymeric regions to the substrate 10. Where the surface of the substrate 10 includes fibers (e.g., where the substrate 10 includes woven, nonwoven, or knit materials on its major surfaces), it may be preferred that the thermoplastic composition encapsulate all or a portion of at least some of the fibers on the surface of the substrate 10 to improve attachment of the discrete polymeric regions to the substrate 10.

Under some conditions the molten thermoplastic composition in the depressions 34 may completely permeate the substrate 10 if, e.g., the substrate 10 is porous throughout its thickness. In other instances, penetration of the molten thermoplastic composition may be limited to the outer layer or layers of the substrate 10.

It should, however, be understood that although the outer surfaces of the substrate 10 may exhibit some porosity, that porosity may not necessarily extend through the entire thickness of the substrate 10. For example, the substrate 10 may have a variety of different layers, with one of the layers being substantially non-porous. In another alternative, the overall thickness of the substrate 10 may render it non-porous as a whole, even though the outer surfaces of the substrate 10 exhibit some porosity as discussed above.

The backup roll 20 may possess a variety of different characteristics depending on the types of substrate materials and/or molten thermoplastic compositions being processed. In some instances, the exterior of the backup roll 20 may be a rubber or other conformable material that conforms to the shape of the transfer roll 30. If a conformable material such as rubber is used, it may, e.g., have a durometer of, e.g., about 10-90 Shore A.

One such variation at the transfer nip is depicted in FIG. 11B, in which a conformable backup roll 130 is depicted as forcing a portion of the substrate 110 into the depression 134 (and the thermoplastic composition 141 contained therein). If the surface of the substrate 110 facing the depression 134 is porous, a portion of the molten thermoplastic composition 141 may be forced in the porous surface of the substrate 110. Forcing the substrate 110 into the depression may be particularly beneficial if the depression 134 is not completely filled with the molten thermoplastic composition 141 to improve the likelihood of contact between the substrate 10 and the molten thermoplastic composition 141.

Alternatively, the surface of the substrate may be forced into the depressions on the transfer roll using a mating backup roll. This variation at the transfer nip is depicted in FIG. 11C in which the backup roll 220 includes protrusions 222 that are complementary to or mate with the depressions 234 on the transfer roll 230. The protrusions 222 would preferably force a substrate into the depressions with the same results and benefits described above with respect to FIG. 11B. A mating backup roll 220 could be formed of any conformable material, nonconformable material, or combination of conformable or nonconformable materials.

Heating or otherwise controlling the temperature of the transfer roll is discussed above. It should also be appreciated that the temperature of the exterior surface of the backup roll may be controlled. For example, it may be desirable to cool the surface of the backup roll to a selected temperature below the temperature of the transfer roll. Cooling of the backup roll may be beneficial in maintaining the integrity of the substrate, particularly if the substrate integrity can be degraded from the heat of the transfer roll (if the transfer roll is heated) and/or the molten thermoplastic composition in the depressions of the transfer roll.

The substrate 10 continues around the backup roll 20 as seen in FIG. 11. In some instances, a portion of the molten thermoplastic composition in the depressions may remain in the depressions 34 while the substrate 10 is pulled away from the transfer roll 30. As a result, the molten thermoplastic composition in the depressions 34 may tend to elongate or string between the depressions in transfer roll 30 and the substrate 10.

A device, such as a hot wire 44 seen in FIG. 11, may be used to sever any strands of thermoplastic composition that may be formed as the substrate 10 separates from the transfer roll 30. Other devices and/or techniques may be used to accomplish the desired severing of any molten thermoplastic composition strands. Examples may include, but are not limited to hot air knives, lasers, etc. Furthermore, under certain conditions, stringing of the thermoplastic composition may not be encountered during manufacturing.

The tendency of the molten thermoplastic composition in the depressions 34 to string as the substrate exits the transfer nip also raises another issue that should be considered when developing processes according to the present invention. That issue is the internal cohesive strength of the substrate 10 and/or the tensile strength of the substrate 10. This issue may be of more concern if the substrate 10 includes a fibrous construction (e.g., woven, nonwoven, or knit fibers) that could be separated from the remainder of the substrate by the forces exerted when the substrate 10 is pulled away from the transfer roll 30. These considerations may be more important if the molten thermoplastic composition has properties (e.g., tackiness, tensile strength, etc.) such that strands of the molten thermoplastic composition can exert forces on the substrate 10 that exceed the internal cohesive strength and/or tensile strength of the substrate 10.

For example, if the substrate 10 includes a resin-bonded nonwoven portion, the temperature of the transfer roll 30 and/or molten thermoplastic composition may rise above the melting temperature of the resin, thereby potentially degrading the internal cohesive strength and/or tensile strength of the substrate 10. Alternatively, a nonwoven substrate may include fibers that have a melting temperature similar to the temperature of the transfer roll 30 and/or molten thermoplastic composition, thereby potentially degrading the internal cohesive strength and/or tensile strength of the substrate 10.

In either instance, the roll temperatures and/or molten thermoplastic composition temperature may need to be controlled to maintain the integrity of the substrate while transferring the molten thermoplastic composition. For example, the backup roll 20 may be cooled to, in turn, cool the substrate 10 to maintain its internal cohesive strength.

In another alternative, heating of the transfer roll 30 and/or backup roll 20 may be used to enhance the internal cohesive strength and/or tensile strength of the substrate 10. For example, if the substrate 10 includes multi-component fibers or fibers having different compositions, some consolidation of the fibers or other components in the substrate 10 may be caused by heating the substrate 10 while transferring the molten thermoplastic composition from the transfer roll 30 to the substrate 10. That consolidation may improve the integrity of the substrate by forming a skin layer or other strength-enhancing structure on or within the substrate 10. Some exemplary processes may be described in, e.g., U.S. Patent No. 5,470,424 (Isaac et al.).

Although the system and method depicted in FIG. 11 produces composite webs with reinforcing discrete polymeric regions on only one major side thereof, those of skill in the art will recognize the modifications required to provide discrete polymeric regions on both major surfaces of the substrate in accordance with the principles of the present invention. One example may include, e.g., forming discrete polymeric regions on one surface of each of two separate substrates, with the two substrates then being laminated together to form a single substrate with discrete polymeric regions on both major surfaces (see, e.g., FIG. 10). Alternatively, a single substrate may be directed into a nip formed by two transfer rolls, with each of the transfer rolls depositing discrete polymeric regions on both sides of the web essentially simultaneously.

Although FIG. 11 depicts the application of only one thermoplastic composition using the transfer roll 30, it will be understood that two or more different thermoplastic compositions may be applied to the exterior surface of the transfer roll 30. FIG. 12 depicts a portion of one system in which a trough 340 is used to deliver three molten thermoplastic compositions (in zones A, B, & C) to the surface of a transfer roll 330 that rotates about an axis 331. The trough 340 may, for example, include barriers 342 such that molten thermoplastic compositions in the different zones of the trough 340 do not mix during processing. In another alternative, separate and distinct troughs could be used for each different thermoplastic composition to be applied to the transfer roll 330.

The transfer roll 330 also includes different sets of depressions 334a, 334b, and 334c over which the different molten thermoplastic compositions may be applied. The depressions in the different zones on transfer roll 330 are differently shaped, have different sizes, and have different spacings. For example, the triangular depressions in zone C are arranged in an irregular, non-repeating pattern while the depressions in zones A & B are arranged in regular, repeating patterns.

With the system of FIG. 12, different sets of discrete polymeric regions may be formed on a single substrate using different thermoplastic compositions. As a result, the thermoplastic compositions may be selected for any of a number of different properties related to manufacturing or end-use performance of the finished articles made using the composite webs.

FIGS. 13 and 14 depict an article that may be manufactured from a composite web according to the methods of the present invention, with FIG. 13

being a plan view of the article and FIG. 14 being a cross-sectional view of the article taken along line 14-14 in FIG. 13. The article includes a frame 560 formed by a reinforcing discrete polymeric region on a substrate 510. The article may be, e.g., a filter in which the frame 560 provides an integral support for substrate 510 which functions as filter media. The frame 560, when deposited as a reinforcing discrete polymeric region, preferably does not require the use of bonding agents (e.g., adhesives, etc.) to secure the frame 560 to the filtration substrate 510.

The depicted article also includes one or more optional reinforcement strips 562 that extend across the central area of substrate 510 defined by the frame 560. The reinforcement strips 562 may also preferably be formed by discrete polymeric regions deposited on the substrate 510 according to the methods of the present invention. The reinforcement strips 562 may be formed of the same or different polymeric compositions as the frame 560.

FIGS. 15 & 16 depict another variation associated with the methods of manufacturing composite webs according to the present invention. FIG. 15 depicts, in a plan view, a portion of a composite web manufactured according to the present invention. The composite web includes a substrate 610 on which two discrete polymeric regions 614 and 615 are located. The substrate 610 includes two opposing edges 611 that extend over the length of the composite web and, together, define the longitudinal length of the composite web.

Discrete polymeric region 614 is provided in the shape of a line of the thermoplastic composition material deposited on the substrate 610 along the general direction of the longitudinal length of the composite web. The discrete polymeric region 614 may be continuous along the longitudinal length of the composite web as shown in FIG. 15.

Discrete polymeric region 615 is a variation of discrete polymeric region 614 in that it is provided in an undulating shape as compared to the relative straight linear shape of the discrete polymeric region 614. The undulating shape of the discrete polymeric region 615 also, however, extends along the direction of the longitudinal length of the composite web. Further, the discrete polymeric region 615 may be continuous along the longitudinal length of the composite web as shown in FIG. 15.

FIG. 16 is a perspective view of one transfer roll 630 that may be used to transfer molten thermoplastic compositions to a substrate in the shapes seen in FIG. 15 according to the methods of the present invention. The transfer roll 630 includes a depression 634 that preferably extends continuously around the outer circumference of the transfer roll 630 to form the discrete polymeric region 614 as depicted in FIG. 15. The transfer roll 630 also includes a depression 635 that also extends around the outer circumference of the roll 630 to form the discrete polymeric region 615 as depicted in FIG. 15.

FIG. 17 depicts another variation associated with the methods of manufacturing composite webs according to the present invention. FIG. 17 depicts, in a plan view, a portion of a composite web manufactured according to the present invention. The composite web includes a substrate 710 on which discrete polymeric regions 714a, 714b, and 714c are located, with the discrete polymeric regions extending across the width of the substrate. The substrate 710 includes two opposing edges 711 that extend over the length of the composite web and, together, define the width and the longitudinal length of the composite web.

Each of the discrete polymeric regions 714a, 714b, and 714c is provided in the shape of a line of the thermoplastic composition material deposited on the substrate 710 in a generally cross-web direction, i.e., extending between the opposing edges 711 of the substrate 710. The discrete polymeric regions 714a, 714b, and 714c present variations from straight lines 714a and 714b to undulating line 714c. Many other variations in placement, shape and/or orientation of reinforcing discrete polymeric regions may be envisioned in connection with methods according to the present invention.

In addition to the provision of articles that include discrete polymeric regions of nonelastomeric thermoplastic compositions on or within a composite web, it may also be desirable to provide such reinforced composite webs with one or more discrete polymeric regions of elastomeric thermoplastic compositions to provide elasticity to the resulting composite webs.

One such example of an article that includes discrete polymeric regions that are either elastomeric or nonelastomeric is depicted in FIGS. 18 & 19. The article 874 may, for example, be provided as a fastening article that may be used in securing a garment (e.g., a diaper, gown, etc.) on a wearer. The article 874 includes a reinforcing ring 814a in the form of a discrete polymeric region formed of a nonelastomeric thermoplastic composition. Although only one discrete polymeric region 814a formed of a nonelastomeric thermoplastic composition is depicted in connection with the article 874, it will be understood that articles of the present invention may include one or more such reinforcing discrete polymeric regions.

The article 874 also includes elastomeric thermoplastic compositions in discrete polymeric regions 814b. Although three such regions are depicted in FIG. 18, it will be understood that articles of the present invention may include only one or more than one discrete polymeric regions formed of elastomeric thermoplastic compositions.

As seen in FIG. 19, a cross-sectional view of the article 874 of FIG. 18 taken along line 19-19 in FIG. 18, the different discrete polymeric regions 814a and 814b are provided on the same major surface of the substrate 810 on which the article 874 is formed. As discussed above, however, it will be understood that any combination of the discrete polymeric regions 814a and 814b may be located on the same or different major surfaces of the substrate 810.

Also depicted in FIG. 19 is an opening 804 formed through the substrate 810 within the surrounding ring of nonelastomeric thermoplastic composition forming the discrete polymeric region 814a. As discussed above in connection with FIG. 10, such openings may be formed by any suitable technique. This opening may, for example, be sized to receive a tab or other structure that fits within the slot formed by the opening 804 formed within the discrete polymeric region 814a in such a manner that retains the tab or other structure within the slot.

The fastening article 874 also includes discrete polymeric regions 814b that preferably function as elastic elements to provide elasticity to the article 874 if the substrate 810 is nonelastic. If the substrate 810 is itself elastic, the discrete polymeric regions 814b may still function as elastic elements that enhance the elasticity of the article 874.

Although the substrate 810 is preferably extensible, a nonextensible substrate 810 can be made extensible by, e.g., providing slits 806 in the substrate

810. The slits 806 are preferably spanned by at least one of the discrete elastomeric polymeric regions 814b. Some exemplary slitting processes to provide or improve extensibility of a substrate are described in International Publication No. WO 96/10481 (Abuto et al.). Other techniques may also be used to provide or improve the extensibility of substrates used in connection with the present invention. For example, the mechanical stretching processes described in U.S. Patent Nos. 4,223,059 (Schwarz) and 5,167,897 (Weber et al.) may be used to provide or improve extensibility.

FIG. 20 depicts a laminated variation of the elastic fastening article 874 of FIGS 18 and 19. The fastening article 974 includes two substrates 910a and 910b that are laminated together, such that the discrete polymeric regions 914a and 914b are located within the composite web 910. The article also includes an opening 904 formed within the reinforcing ring formed by the nonelastomeric thermoplastic composition of the discrete polymeric region 914a.

FIGS. 21-23 depict various views of another fastening article according to the present invention. Fastening tab 1074 includes a substrate 1010 on which a variety of different discrete polymeric regions are located. The different discrete polymeric regions provide a reinforcing surrounding ring (1014a) for attaching the article 1074 to a complementary structure and elastic elements (1014b) to provide elasticity to the fastening article 1074. The tab 1074 preferably includes an elongation axis 1078 seen in FIG. 21.

Discrete polymeric region 1014a is provided proximate the distal end of the fastening article 1074. FIG. 22 is a cross-sectional view taken along line 22-22 in FIG. 21 and depicts a pleat 1006 formed in the substrate 1010, with the elastic elements 1014b spanning the pleat 1006. In the embodiment depicted in FIG. 22, the substrate 1010 includes only one pleat, although it should be understood that the articles of the present invention may include one or more pleats as desired for extensibility purposes.

The discrete polymeric region 1014a is formed of nonelastomeric materials and, as such, the discrete polymeric region 1014a may also function to distribute stresses over the width of the article 1074 (where the width is measured generally transverse to the elongation axis 1078 depicted in FIG. 21). It may be desirable to distribute the forces applied during elongation of the article 1074 to reduce or prevent necking or roping of the article 1074. Force distribution may also be helpful to improve uniformity in the forces seen across the width of the article 1074.

In the depicted embodiment, the elastomeric discrete polymeric regions 1014b are located on the same surface of the substrate 1010 as the nonelastomeric discrete polymeric region 1014a. Each of the elastomeric discrete polymeric regions 1014b preferably includes a length that is substantially aligned with the elongation axis 1078. For the purposes of the present invention, the length of the discrete polymeric regions 1014b is the longest straight line dimension of the discrete polymeric regions 1014b as measured along the surface of the substrate 1010.

Another feature of the elastomeric discrete polymeric regions 1014b is their nonuniform or changing width. As seen in FIG. 21, the discrete polymeric regions 1014b become wider when moving away from the discrete polymeric region 1014a. If the height or thickness of the discrete polymeric regions 1014b above the surface of the substrate 1010 is constant, the net result of the changing width depicted in FIG. 21 is that the amount of elastomeric material in the discrete polymeric regions 1014b increases when moving away from the discrete polymeric region 1014a. The changing bulk of elastomeric material may, e.g., provide an article 1074 that has different elasticity and/or elongation properties at different locations along the elongation axis 1078. Many other variations in the distribution of elastomeric material in the discrete polymeric regions 1014b may be used to tailor the elasticity and/or elongation properties of the fastening tab 1074, e.g., adjusting the thickness of the polymeric regions, the materials used, etc.

FIG. 24 depicts one composite web 1100 that may be, at least in part, manufactured using the system of FIG. 24. The composite web 1100 includes a variety of different discrete polymeric regions 1114a and 1114b located thereon. In addition, the composite web 1100 includes lines of separation 1117 that define the boundaries of a number of different fastening tabs similar to those described above with respect to FIGS 21-23. The lines of separation 1117 define a nested configuration of fastening articles including the nonelastomeric discrete polymeric regions 1114a and elastomeric discrete polymeric regions 1114b in a manner that may reduce waste when the composite web 1100 is separated along the lines of separation 1117 to provide the desired fastening articles. The lines of separation 1117 may take on any suitable form that facilitates separation of the composite web 1100 along the lines of separation, e.g., score lines, lines of weakness, lines of perforations, etc.

The composite web 1100 preferably has a length that extends along the direction of the straight line of separation 1117 extending from left to right in FIG. 24. Although the composite web 1100 includes only two pairs of nested tabs across the width of the composite web 1100 (where width is transverse to length), it will be understood that any desired number of nested pairs of tabs may be provided in a single composite web according to the present invention.

Another optional feature depicted in FIG. 24 are bonding sites 1128 that, in the depicted embodiment, is provided in the form of strips extending along the central line of separation bisecting the composite web 1100, and along the edges of the composite web 1100. Although depicted as continuous strips that extend along the length of the composite web 1100, each of the elastic articles defined by the lines of separation 1117 may alternatively include one or more discrete bonding sites if so desired.

The bonding sites 1128 may be provided to assist in the attachment of the elastic articles defined by the lines of separation 1117 to a larger article, e.g., a diaper, gown, etc. To assist in attachment, the bonding sites 1128 may take a variety of configurations. For example, the bonding site may be a consolidated area of a nonwoven or woven fabric amenable to thermal or other consolidation techniques. Alternatively, or in addition to consolidation, the bonding sites may include one or more materials that assist in bonding, e.g., block copolymers, ethylene vinyl acetates, tackified ethylene vinyl acetates, adhesives (pressure sensitive, curable, heat activated, etc.), amorphous polyolefins, etc. The specific selection of materials to locate in the bonding sites 1128 will depend on the type of bonding to be performed and the materials to be bonded.

One advantage of the bonding sites 1128 is that they can be formed of materials that are particularly amenable to the attachment technique to be used, e.g., heat sealing, ultrasonic welding, etc. Another advantage is that the bonding sites can be sized such that they are large enough to accomplish their function, but not so large that any materials used in the bonding sites are wasted. Depending on the composition of the materials to be provided at the bonding sites, they may be formed by the transfer methods described herein if a thermoplastic composition is to be used in the bonding sites 1128.

If the elastic articles defined by the lines of separation 1117 are to be used as, e.g., fastening articles, it may be preferred that the bonding sites 1128 be adapted to receive a mechanical fastener or fasteners that may be bonded to the tab separately. Alternatively, an adhesive (e.g., pressure sensitive, curable, heat activated, etc.) or cohesive material could be provided within the bonding sites 1128.

The deposition of discrete polymeric regions formed of elastomeric thermoplastic compositions on a substrate may be accomplished in much the same manner as used in connection with the deposition of discrete polymeric regions formed of nonelastomeric thermoplastic compositions discussed above. The different thermoplastic compositions may be transferred to the substrates using a zoned system as discussed in connection with FIG. 12, or the different thermoplastic compositions may by transferred to the substrates at different transfer stations.

An alternative system may include lamination of two substrates together, with each substrate including one or the other of the elastomeric or nonelastomeric discrete polymeric regions as described, e.g., above. FIG. 25 is a schematic depiction of one such system and method in which a transfer station 1230a produces nonelastomeric discrete polymeric regions 1214a on substrate 1210a. Transfer station 1230b produces elastomeric discrete polymeric regions 1214b on substrate 1210b. Each of the transfer stations may, e.g., be constructed similar to the system depicted in FIG. 11.

Both substrates 1210a and 1210b are directed into a laminating station 1240 that produces a laminated composite web 1200 which, in the depicted embodiment, would provide both the nonelastomeric discrete polymeric regions 1214a and the elastomeric discrete polymeric regions 1214b located within the surrounding layers of substrates 1210a and 1210b. Alternatively, it will be understood that one or both sets of discrete polymeric regions could be laminated to the exterior of the laminated composite web 1200.

FIG. 26 depicts another system and method in which the different discrete polymeric regions 1314a and 1314b are sequentially deposited on the same substrate 1310. The system and method includes a transfer station 1330a in which the substrate 1310 is processed to provide a first set of discrete polymeric regions 1314a thereon. The substrate 1310 with discrete polymeric regions 1314a is then directed into a second transfer station 1330b in which a second set of discrete polymeric regions 1314b is provided on the substrate 1310. Although the second set of discrete polymeric regions 1314b are depicted as being located on the opposite side of the substrate 1310 from the first set of discrete polymeric regions 1314a, it will be understood that both sets of discrete polymeric regions could be located on the same side of the substrate 1310. In yet another alternative, the different sets of discrete polymeric regions could both be located on both sides of the substrate 1310.

The order in which any elastomeric and nonelastomeric discrete polymeric regions are deposited on the substrate 1310 may vary. Further, it will be understood that additional transfer stations could be added to the system and method depicted in FIG. 26 to provide more of the same discrete polymeric regions or yet additional different discrete polymeric regions on the substrate 1310. Further, additional stations may be added to laminate one or more additional substrates to the substrate 1310.

As with the nonelastomeric thermoplastic compositions described above, elastomeric thermoplastic compositions used for elastic discrete polymeric regions should be capable of flowing or entering into depressions formed in a polymer transfer roll as will be described below. Suitable elastomeric thermoplastic compositions are those that are melt processable. Such polymers are those that will flow sufficiently to at least partially fill the depressions, yet not significantly degrade during a melt process. A wide variety of elastomeric thermoplastic compositions have suitable melt and flow characteristics for use in the process of the present invention depending on the geometry of the depressions and the processing conditions. It may further be preferred that the melt processable materials and conditions of processing are selected such that any viscoelastic recovery properties of the thermoplastic composition do not cause it to significantly withdraw from the wall(s) of the depressions until transfer of the thermoplastic composition to a substrate is desired.

As used in connection with the present invention, "elastomeric" means that the material will substantially resume its original shape after being stretched. Further, the elastomeric materials may preferably sustain only small permanent set following deformation and relaxation, which set is preferably no greater than about 30 percent and more preferably no greater than about 20 percent of the original length at moderate elongation, e.g., about 50%. The elastomeric materials can be both pure elastomers and blends with an elastomeric phase or content that will still exhibit substantial elastomeric properties at room temperature. U.S. Patent No. 5,501,679 (Krueger et al.) provides some further discussion regarding elastomeric materials that may be considered for use in connection with the present invention.

The elastomeric thermoplastic compositions can include one or more polymers. For example, the elastomeric thermoplastic composition could be a blend with an elastomeric phase such that the composition exhibits elastomeric properties at room temperature. Suitable elastic thermoplastic polymers include block copolymers such as conventional A-B or A-B-A block copolymers (e.g., styrene-isoprene-styrene, styrene-butadiene-styrene, styrene-ethylene-butylene-styrene block copolymers), elastomeric polyurethanes, olefinic elastomers, particularly elastomeric ethylene copolymers (e.g., ethylene vinyl acetates, ethylene/octene copolymer elastomers, ethylene/propylene/diene terpolymer elastomers), as well as mixtures of these with each other, with other elastomeric thermoplastic polymers, or with nonelastomeric thermoplastic polymers.

The elastomeric thermoplastic compositions used in connection with the present invention can also be combined with various additives for desired effect. These include, for example, fillers, viscosity reducing agents, plasticizers, tackifiers, colorants (e.g., dyes or pigments), antioxidants, antistatic agents, bonding aids, antiblocking agents, slip agents, stabilizers (e.g., thermal and ultraviolet), foaming agents, microspheres, glass bubbles, reinforcing fibers (e.g., microfibers), internal release agents, thermally conductive particles, electrically conductive particles, and the like. The amounts of such materials that can be useful in the thermoplastic compositions can be readily determined by those skilled in the art of processing and using such materials.

In addition to the deposition of nonelastic or elastic thermoplastic polymer in discrete regions, it is also contemplated that additional materials can be coated onto a major surface of the substrate using known methods. Such materials could be, for example adhesives, as described in, e.g., U.S. Patent Nos. 5,019,071 (Bany et al.); 5,028,646 (Miller et al.); and 5,300,057 (Miller et al.); or cohesives as described in, e.g. U.S. Patent Nos. 5,389,438 (Miller et al.) and 6,261,278 (Chen et al.).

EXAMPLE

The following example is provided to enhance understanding of the present invention. The example is not intended to limit the scope of the invention.

To demonstrate that two different polymers can be used to produce both an elastic region and a reinforcing region on two different substrates followed by lamination, a web was prepared using the apparatus shown in FIG. 11, except a second transfer roll, similar to the transfer roll 30, a second rubber backup roll, similar to the rubber backup roll 20, a second doctor blade, similar to the doctor blade 42, and a second hot wire, similar to the hot wire 44, were used to transfer a discrete reinforcing polymer region to a second nonwoven substrate (SONTARA 8001 spunlaced polyester, Dupont). KRATON G-1657 SEBS block copolymer was used as the molten polymer for delivery to transfer roll 30 at a melt temperature of 246^{O}C using a 40 mm twin screw extruder. SONTARA 8001 spunlaced polyester (Dupont) was used as the substrate 10.

Transfer roll 30 was machined with seven different areas arranged around and across the periphery of the roll, each area having a specific depression geometry and spacing. Area 1 was machined using a computer controlled milling machine (2 mm ball diameter) to have depressions in the shape of grooves parallel to the roll axis 25 mm long, 0.75 mm in depth, 13 mm end to end spacing measured along the roll axis, 7.5 mm center to center spacing between grooves measured normal to the roll axis, with 12 rows of staggered grooves. Each row of grooves starting with a 6.4 mm shift from the previous row to create the staggered pattern. Area 2 was machined using a computer controlled milling machine (2 mm ball diameter) to have 15 rows of grooves parallel to the roll axis 114 mm long, 0.375 mm in depth, and 6.0 mm center to center spacing between grooves measured normal to the roll axis. Area 3 was machined using a computer controlled milling machine (2 mm ball diameter) to have 15 rows of grooves parallel to the roll axis 114 mm long, 0.5 mm in depth, and 6.0 mm center to center spacing between grooves measured normal to the roll axis. Area 4 was machined using a computer controlled milling machine (2 mm ball diameter) to have 12 rows of grooves parallel to the roll axis 114 mm long, 0.5 mm in depth, and 7.5 mm center to center spacing between grooves measured normal to the roll axis. Area 5 was machined using a computer controlled milling machine (2 mm ball diameter) to have 12 rows of grooves parallel to the roll axis 114 mm long, 0.875 mm in depth, and 7.5 mm center to center spacing between grooves measured normal to the roll axis. Area 6 was machined using a computer controlled milling machine (2 mm ball diameter) to have 9 rows of grooves parallel to the roll axis 114 mm long, 1.0 mm in depth, and 10.0 mm center to center spacing between grooves measured normal to the roll axis. Area 7 was machined using a computer controlled milling machine (3 mm ball diameter) to have 9 rows of grooves parallel to the roll axis 114 mm long, 0.75 mm in depth, and 10.0 mm center to center spacing between grooves measured normal to the roll axis.

The temperature of the second transfer roll was 232^{O}C. The brass doctor blade 42 having a thickness of 1.5 mm at the point of contact with the transfer roll 30, was pressed firmly against and normal to the exterior surface of the transfer roll at a pressure of 123 N/lineal cm. A nip pressure of 12 N/lineal cm between the transfer roll and rubber backup roll (20^{O}C) was used. SC-917 polypropylene (Basell Olefins) was used as the molten polymer for delivery to the second transfer roll at a melt temperature of 227^{O}C using a 19 mm single screw extruder.

The second transfer roll was machined using a computer controlled milling machine to have a circle of 8 depressions around the periphery of the roll near the center of the roll positioned so as not to overlap the depressions in transfer roll 30 forming the elastic regions. The depressions were elliptical in shape 7.6 cm long and 1.9 cm in width at the widest point of the ellipse. The long axis of each ellipse was parallel to the machine direction (downweb). The ellipses were arranged with a center-to-center spacing of 8.9 cm. The elliptical depressions were machined in a seven step process. Step 1 consisted of milling 0.333 mm depth cells using a 2 mm tool in a 7.6 cm by 1.9 cm elliptical pattern. Step 2 consisted of milling 0.500 mm depth cells using a 3 mm tool. Step 3 consisted of milling 0.666 mm depth cells using a 4 mm tool. Step 4 consisted of milling 0.833 mm depth cells using a 5 mm tool. Step 5 consisted of milling 0.999 mm depth cells using a 6 mm tool. Step 6 consisted of milling 1.165 mm depth cells using a 7 mm tool. Step 7 consisted of milling 1.332 mm depth cells using a 8 mm tool. The cells were positioned such that the deeper cells were in the middle of the ellipse with progressively shallower cells tapering outwards towards the perimeter of the ellipse.

The temperature of the transfer roll was 227^{O}C. The pressure of the doctor blade against the second transfer roll was 123 N/lineal cm. A nip pressure of 25 N/lineal cm between the transfer roll and rubber backup roll (20^{O}C) was used. SONTARA 8001 spunlaced polyester (Dupont) was used as the substrate. A nip pressure of 6 N/lineal cm between the two rubber rolls was used to laminate the two substrates together resulting in a web that had discrete elastic polymeric regions and discrete reinforcing polymer regions.

The preceding specific embodiments are illustrative of the practice of the invention. This invention may be suitably practiced in the absence of any element or item not specifically described in this document. The complete disclosures of all patents, patent applications, and publications are incorporated into this document by reference as if individually incorporated. Various modifications and alterations of this invention will become apparent to those skilled in the art without departing from the scope of this invention. It should be understood that this invention is not to be unduly limited to illustrative embodiments set forth herein.

CLAIMS:

1. An elastic article comprising:

a substrate comprising first and second major surfaces;

one or more reinforcing discrete polymeric regions attached to the substrate, wherein each reinforcing discrete polymeric region of the one or more reinforcing discrete polymeric regions comprises a nonelastomeric thermoplastic composition that infiltrates a portion of substrate; and

one or more elastic elements attached to the substrate, wherein each elastic element of the one or more elastic elements comprises an elastic discrete polymeric region comprising an elastomeric thermoplastic composition that infiltrates a portion of the substrate.

2. An article according to claim 1, wherein the substrate comprises a laminated substrate comprising a fist substrate and a second substrate, wherein each elastic element of the one or more elastic elements is located between the first substrate and the second substrate.

3. An article according to claim 1, wherein at least one elastic element of the one or more elastic elements is located on the first major surface of the substrate.

4. An article according to claim 1, wherein at least one elastic element of the one or more elastic elements is located on the second major surface of the substrate

5. An article according to claim 1, further comprising an elongation axis, wherein each elastic element of the one or more elastic elements comprises a length greater than a width, and wherein the length of each elastic element of the one or more elastic elements is aligned with the elongation axis.

6. An article according to claim 5, wherein the amount of elastomeric thermoplastic in each elastic element of the one or more elastic elements

increases when moving away from the one or more reinforcing discrete polymeric regions along the elongation axis.

7. An article according to claim 1, wherein at least one reinforcing discrete polymeric region of the one or more reinforcing discrete polymeric regions comprises an opening formed through the substrate within a surrounding ring formed of the nonelastomeric thermoplastic composition of the at least one reinforcing discrete polymeric region.

8. An article according to claim 1, further comprising one or more slits formed through the substrate, wherein at least one of the one or more elastic elements spans at least one slit of the one or more slits.

9. An article according to claim 1, further comprising one or more pleats formed in the substrate, wherein at least one of the one or more elastic elements spans at least one pleat of the one or more pleats.

10. An article according to claim 9, wherein at least some elastic elements of the one or more elastic elements spans only one pleat of the one or more pleats.

11. An article according to claim 9, at least some elastic elements of the one or more elastic elements span two or more pleats of the one or more pleats.

12. A method for producing a composite web, the method comprising:

providing a first substrate comprising a first major surface and a second major surface, a plurality of discrete elastomeric polymeric regions formed of an elastomeric thermoplastic composition located on the first major surface of the first substrate, wherein each discrete elastomeric polymeric region of the plurality of discrete elastomeric polymeric regions infiltrates the first major surface of the first substrate;

providing a second substrate comprising a first major surface and a second major surface, a plurality of discrete nonelastomeric polymeric regions formed of a nonelastomeric thermoplastic composition located on the first major surface of the second substrate, wherein each discrete nonelastomeric polymeric region of the plurality of discrete nonelastomeric polymeric regions infiltrates the first major surface of the second substrate; and

laminating the first substrate to the second substrate.

13. A method according to claim 12, wherein the plurality of discrete elastomeric polymeric regions on the first major surface of the first substrate are located between the first substrate and the second substrate after the laminating.

14. A method according to claim 12, wherein the plurality of discrete elastomeric polymeric regions on the first major surface of the first substrate are located between the first substrate and the second substrate after the laminating, and wherein the laminating comprises attaching the second major surface of the second substrate to the first substrate.

15. A method according to claim 12, wherein providing the first substrate comprises:

providing a transfer roll comprising an exterior surface that comprises one or more depressions formed therein;

delivering a molten elastomeric thermoplastic composition onto the exterior surface of the transfer roll;

wiping the molten elastomeric thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten elastomeric thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten elastomeric thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten elastomeric thermoplastic composition from the exterior surface of the transfer roll; and

transferring at least a portion of the molten elastomeric thermoplastic composition in the one or more depressions to a first major surface of a first substrate by contacting the first major surface of the first substrate to the exterior surface of the transfer roll and the molten elastomeric thermoplastic composition in the one or more depressions, followed by separating the first substrate from the transfer roll to form the plurality of discrete elastomeric polymeric regions on the first major surface of the first substrate.

16. A method according to claim 15, wherein the transferring further comprises forcing the first major surface of the first substrate against the exterior surface of the transfer roll and the molten elastomeric thermoplastic composition in the one or more depressions.

17. A method for producing a composite web, the method comprising:

providing a substrate comprising a first major surface and a second major surface;

forming a plurality of discrete elastomeric polymeric regions formed of an elastomeric thermoplastic composition on the first major surface of the substrate, wherein each discrete elastomeric polymeric region of the plurality of discrete elastomeric polymeric regions infiltrates the first major surface of the substrate; and

forming a plurality of discrete nonelastomeric polymeric regions formed of a nonelastomeric thermoplastic composition located on the first major surface or the second major surface of the substrate, wherein each discrete nonelastomeric polymeric region of the plurality of discrete nonelastomeric polymeric regions infiltrates the second substrate.

18. A method according to claim 17, wherein forming the plurality of discrete elastomeric polymeric regions comprises:

providing a transfer roll comprising an exterior surface that comprises one or more depressions formed therein;

delivering a molten elastomeric thermoplastic composition onto the exterior surface of the transfer roll;

wiping the molten elastomeric thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten elastomeric thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten elastomeric thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten elastomeric thermoplastic composition from the exterior surface of the transfer roll; and

transferring at least a portion of the molten elastomeric thermoplastic composition in the one or more depressions to the first major surface of the substrate by contacting the first major surface of the substrate to the exterior surface of the transfer roll and the molten elastomeric thermoplastic composition in the one or more depressions, followed by separating the first substrate from the transfer roll to form the plurality of discrete elastomeric polymeric regions on the first major surface of the substrate.

19. A method according to claim 18, wherein the transferring further comprises forcing the first major surface of the substrate against the exterior surface of the transfer roll and the molten elastomeric thermoplastic composition in the one or more depressions.

20. A method according to claim 17, wherein forming the plurality of discrete nonelastomeric polymeric regions comprises:

providing a transfer roll comprising an exterior surface that comprises one or more depressions formed therein;

delivering a molten nonelastomeric thermoplastic composition onto the exterior surface of the transfer roll;

wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten nonelastomeric thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten nonelastomeric thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll; and

transferring at least a portion of the molten nonelastomeric thermoplastic composition in the one or more depressions to the first major surface or the second major surface of the substrate by contacting the substrate to the exterior surface of the transfer roll and the molten nonelastomeric thermoplastic composition in the one or more depressions, followed by separating the first substrate from the transfer roll to form the plurality of discrete nonelastomeric polymeric regions on the substrate.

21. A method according to claim 20, wherein the transferring further comprises forcing the substrate against the exterior surface of the transfer roll and the molten elastomeric thermoplastic composition in the one or more depressions.

22. A composite web comprising:

a substrate comprising first and second major surfaces;

a plurality of nonelastomeric discrete polymeric regions attached to the substrate, wherein each nonelastomeric discrete polymeric region of the plurality of nonelastomeric discrete polymeric regions comprises a nonelastomeric thermoplastic composition that infiltrates a portion of substrate;

a plurality of elastomeric discrete polymeric regions attached to the substrate, wherein each elastomeric discrete polymeric region of the plurality of elastomeric discrete polymeric regions comprises an elastomeric thermoplastic composition that infiltrates a portion of the substrate; and

one or more lines of separation in the composite web, wherein the one or more lines of separation define boundaries of a plurality of distinct articles in the composite web, and wherein each article of the plurality of articles comprising at least one nonelastomeric discrete polymeric region of the plurality of nonelastomeric discrete polymeric regions and at least one elastomeric discrete polymeric region of the plurality of elastomeric discrete polymeric regions.

23. A composite web according to claim 22, wherein the substrate comprises a laminated substrate comprising a fist substrate and a second substrate, wherein each elastomeric discrete polymeric region of the plurality of elastomeric discrete polymeric regions is located between the first substrate and the second substrate.

24. A composite web according to claim 22, wherein the substrate comprises a laminated substrate comprising a fist substrate and a second substrate, wherein

each elastomeric discrete polymeric region of the plurality of elastomeric discrete polymeric regions is located on the first major surface or the second major surface of the substrate.

25. A composite web according to claim 22, wherein the substrate comprises a laminated substrate comprising a fist substrate and a second substrate, wherein each nonelastomeric discrete polymeric region of the plurality of nonelastomeric discrete polymeric regions is located between the first substrate and the second substrate

26. A composite web according to claim 22, wherein the substrate comprises a laminated substrate comprising a fist substrate and a second substrate, wherein each nonelastomeric discrete polymeric region of the plurality of nonelastomeric discrete polymeric regions is located on the first major surface or the second major surface of the substrate.

Docket No. 57190US002

COMPOSITE WEBS WITH REINFORCING POLYMERIC REGIONS AND ELASTIC POLYMERIC REGIONS

ABSTRACT OF THE DISCLOSURE

Methods of manufacturing composite webs including a substrate with one or more reinforcing discrete polymeric regions located on or within the composite web are disclosed. Molten nonelastomeric thermoplastic material of the discrete polymeric region is forced against the substrate by a transfer roll. If the substrate is porous, fibrous, etc., a portion of the nonelastomeric thermoplastic composition may infiltrate the substrate and/or encapsulate fibers of the substrate. The composite webs also include elastomeric thermoplastic material in discrete polymeric regions on or within the composite web.

"EXPRESS MAIL" MAILING LABEL NUMBER EL 888 272 688 US

DATE OF DEPOSIT November 5, 2001

I HEREBY CERTIFY THAT THIS PAPER OR FEE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE "EXPRESS MAIL POST OFFICE TO ADDRESSEE" SERVICE UNDER 37 CFR 1.10 ON THE DATE INDICATED ABOVE AND IS ADDRESSED TO THE ASSISTANT COMMISSIONER FOR PATENTS, Attn: Box Patent Application. WASHINGTON D.C. 20231

PRINTED NAME Rachel Gagliardi-Graham

SIGNATURE Rachel Gagliardi-Graham

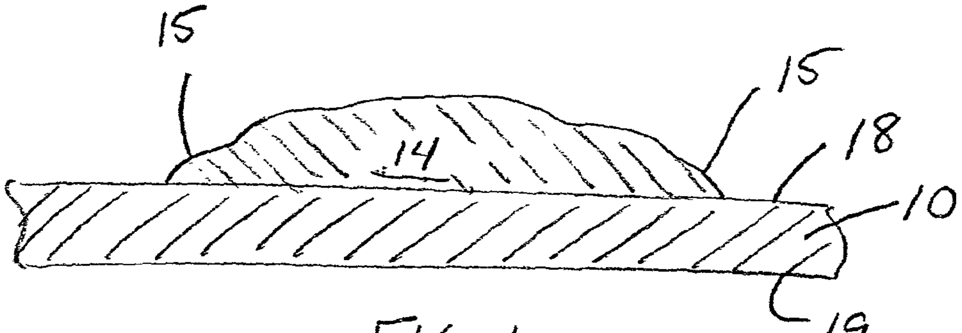


FIG. 1

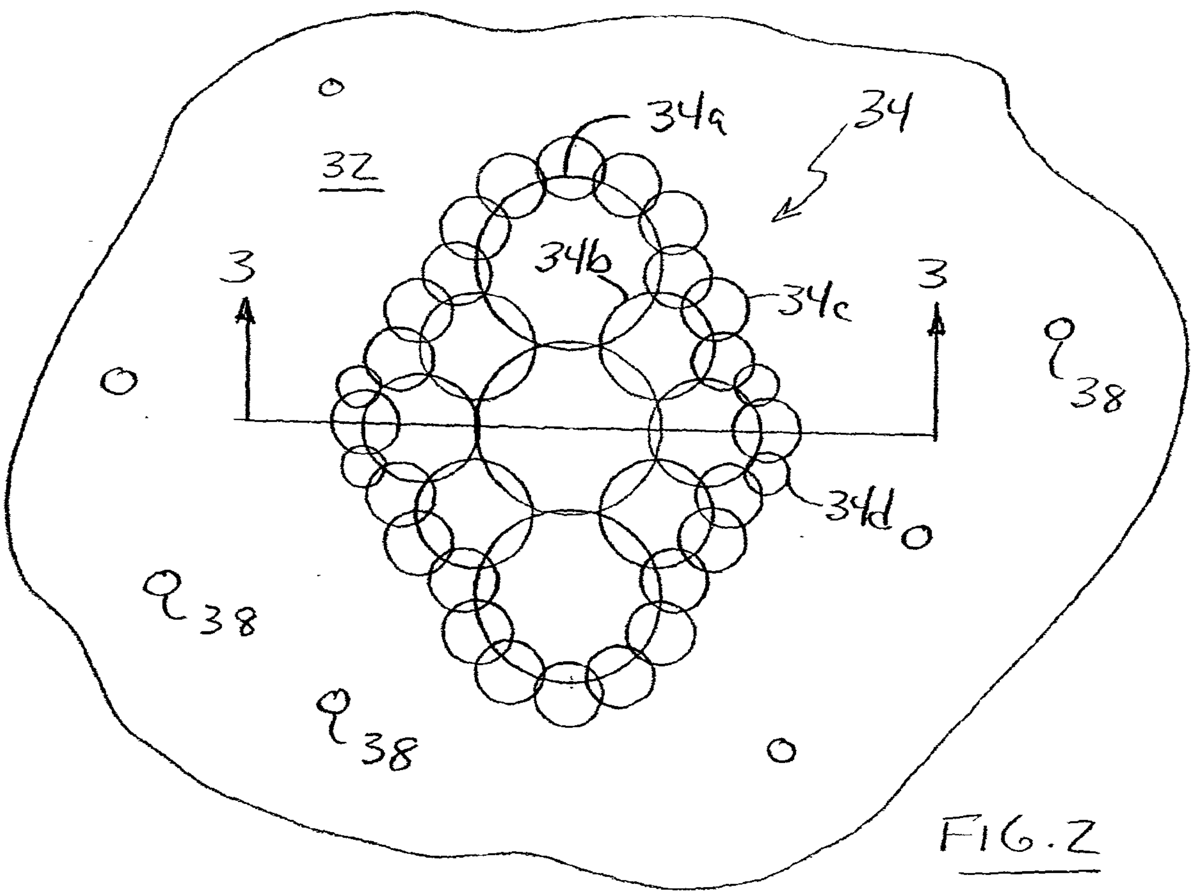


FIG. 2

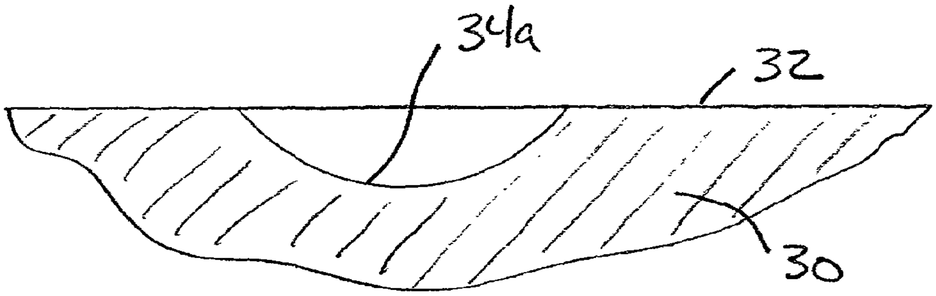


FIG. 3A

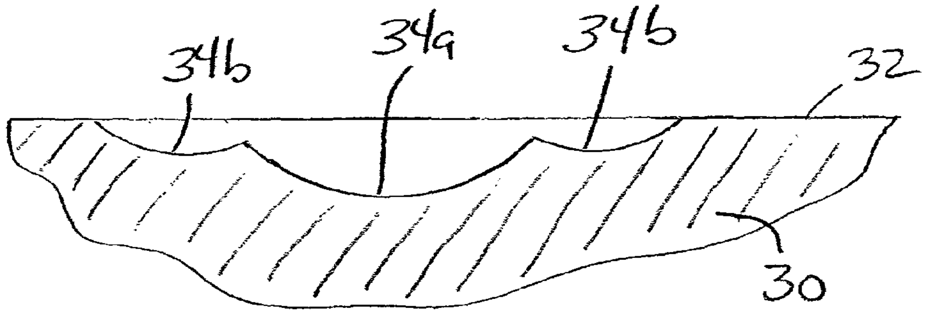


FIG. 3B

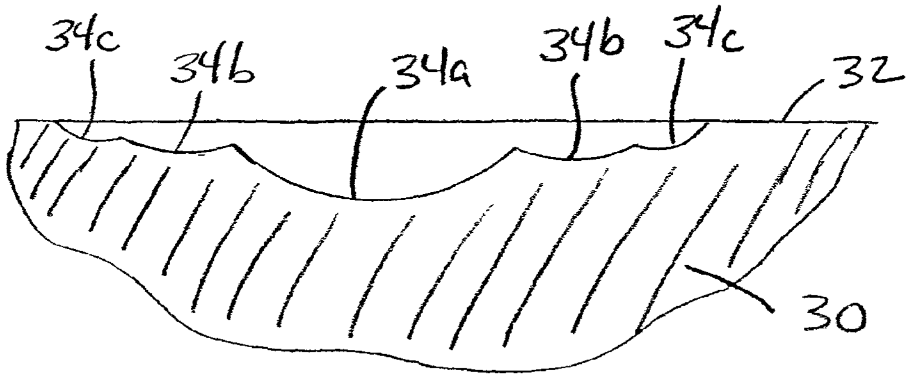


FIG. 3C

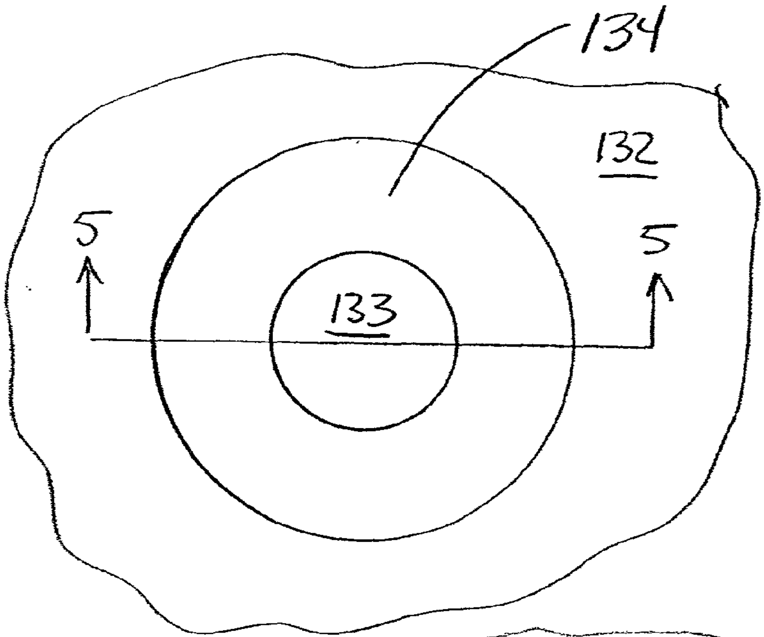


FIG. 4

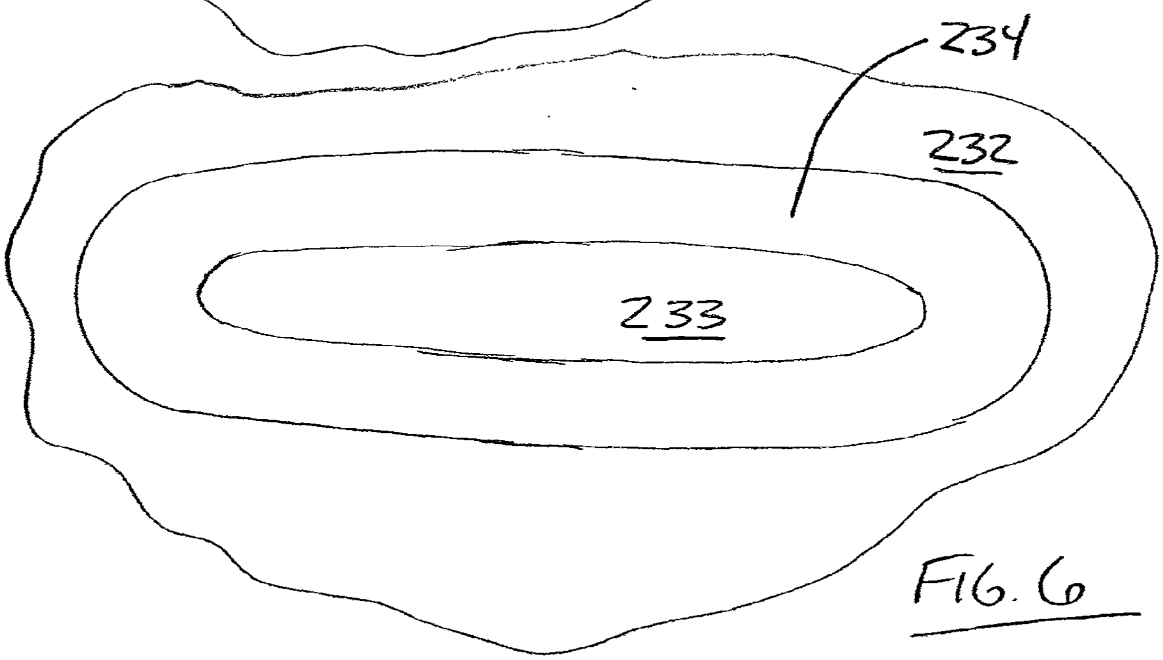


FIG. 6

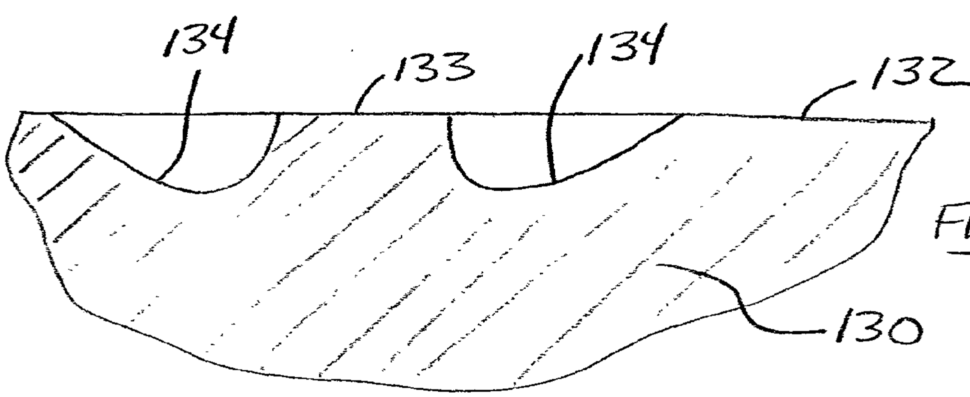


FIG. 5

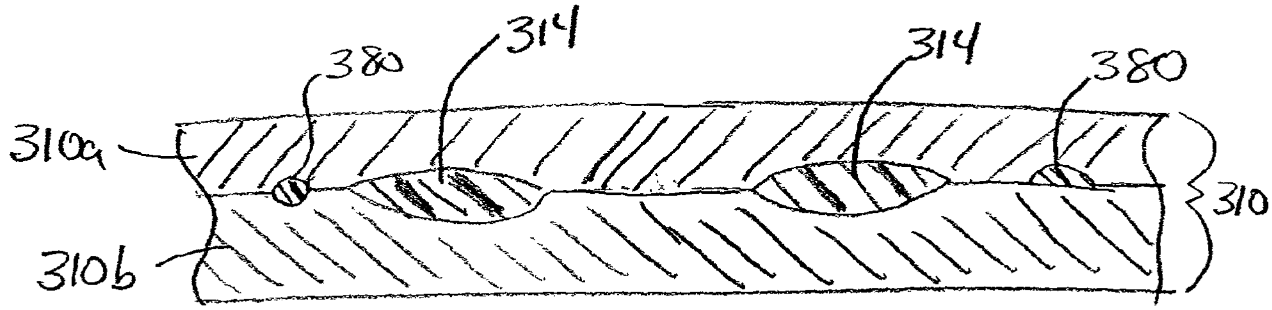


FIG. 7

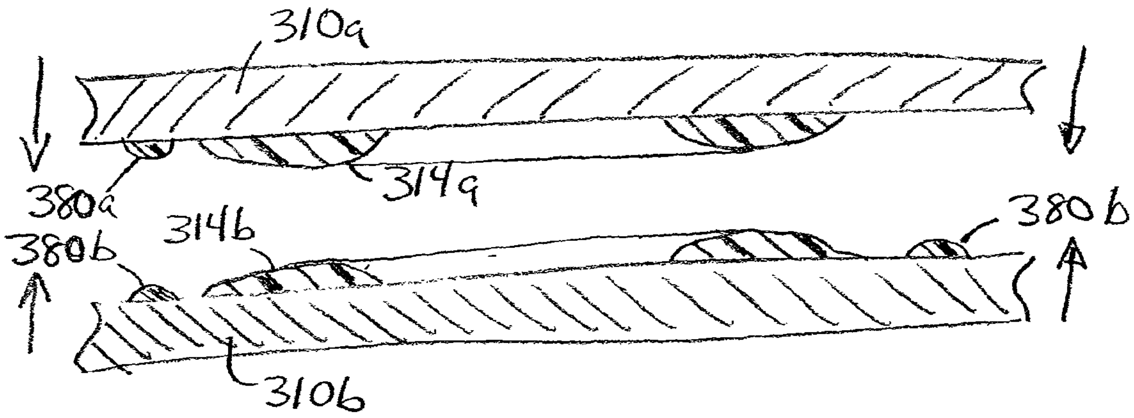


FIG. 8

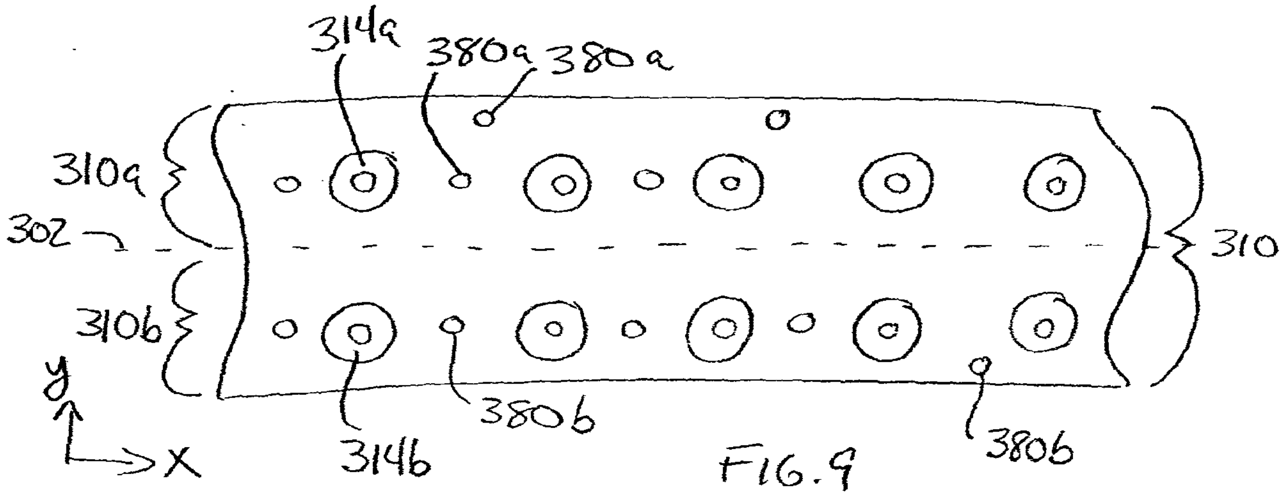


FIG. 9

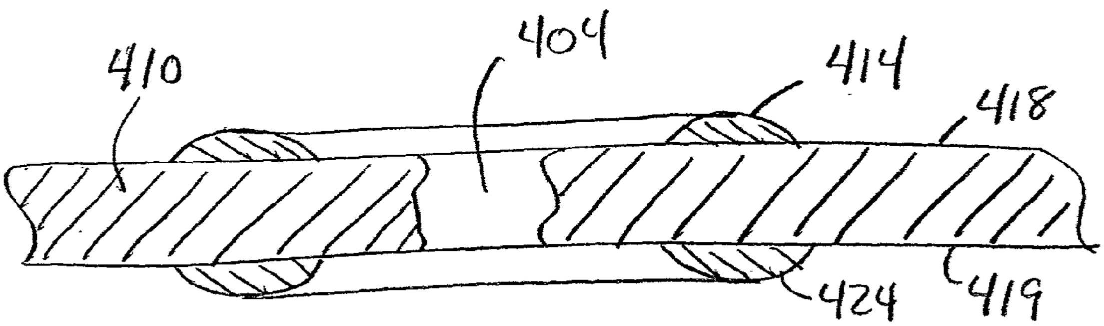


FIG. 10

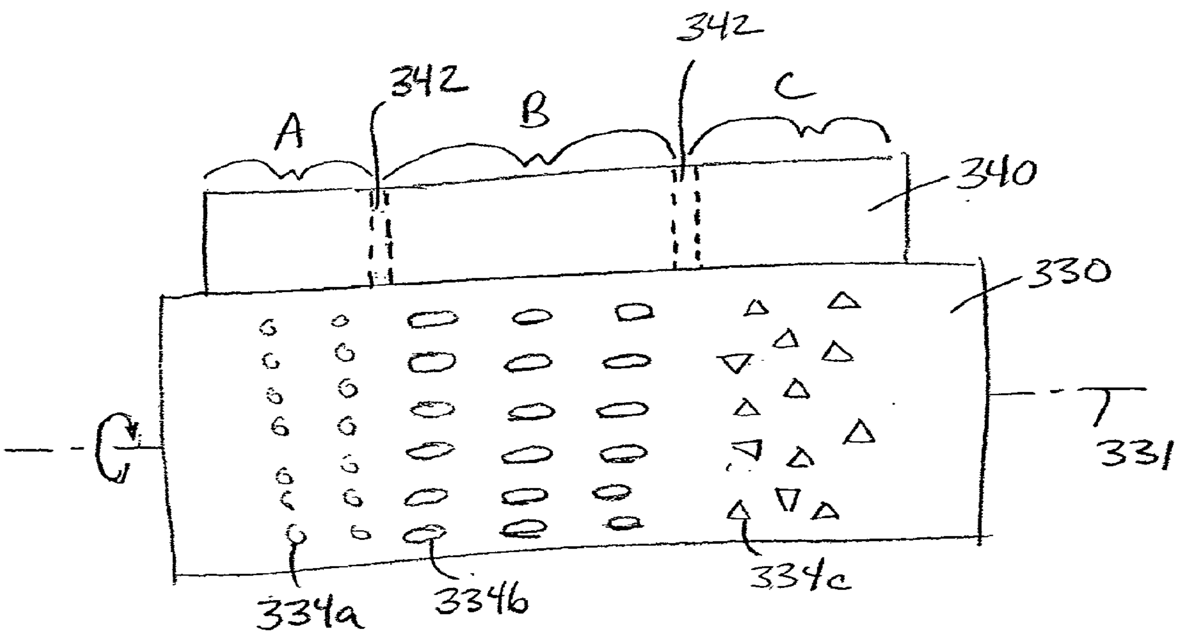


FIG. 12

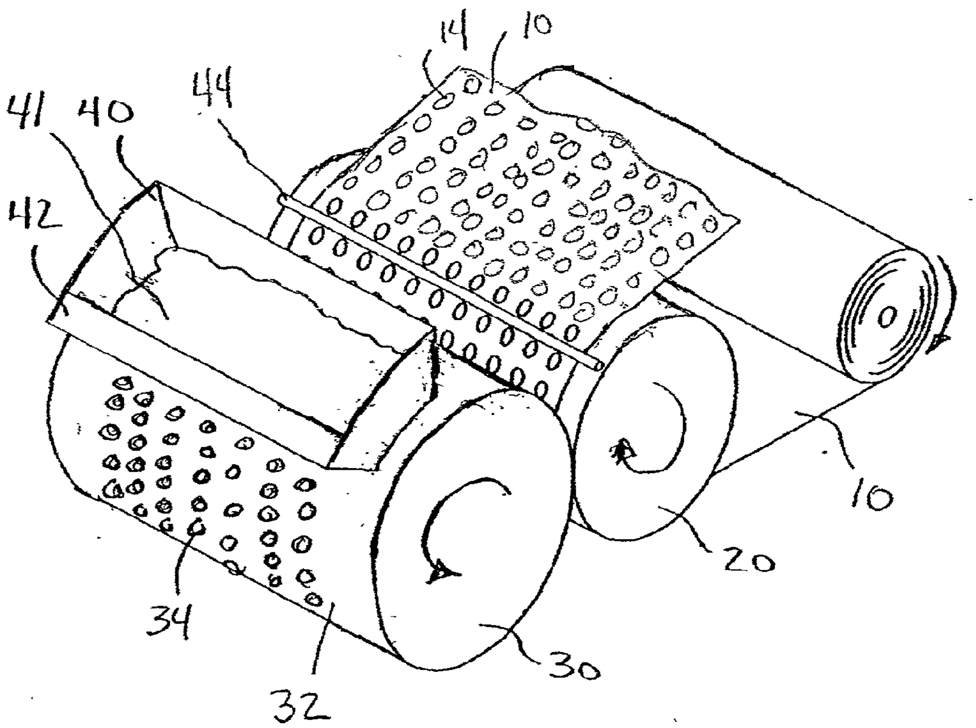


FIG. 11

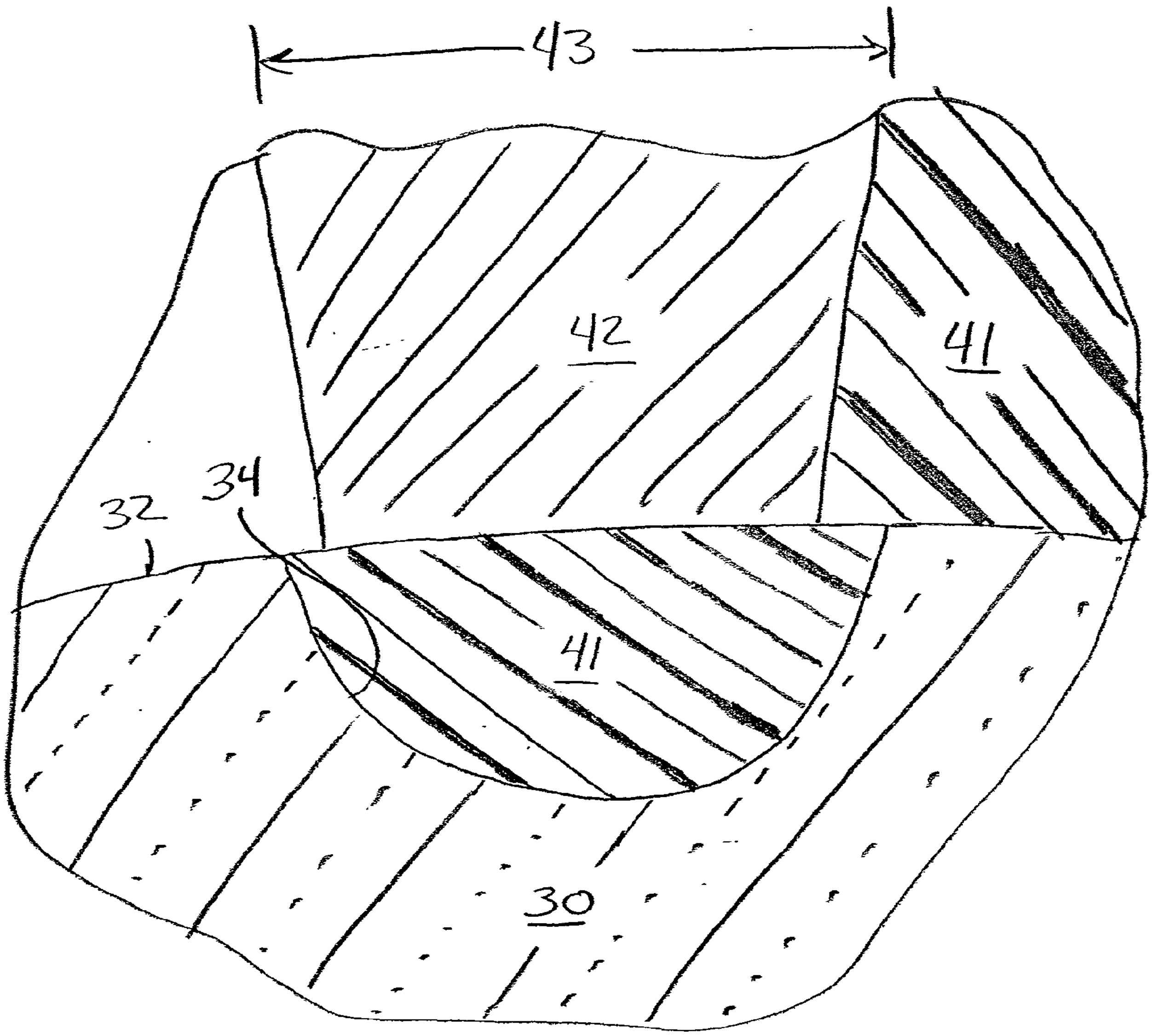


FIG. 11A

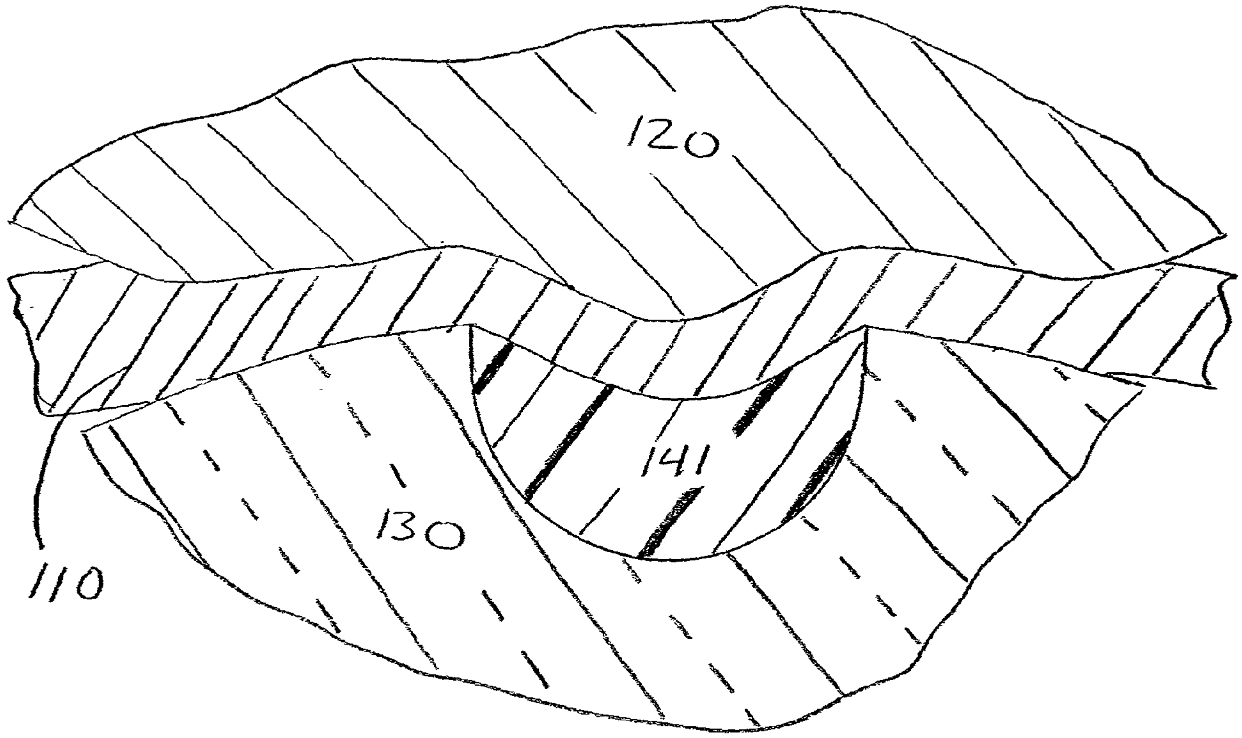


FIG. 11B

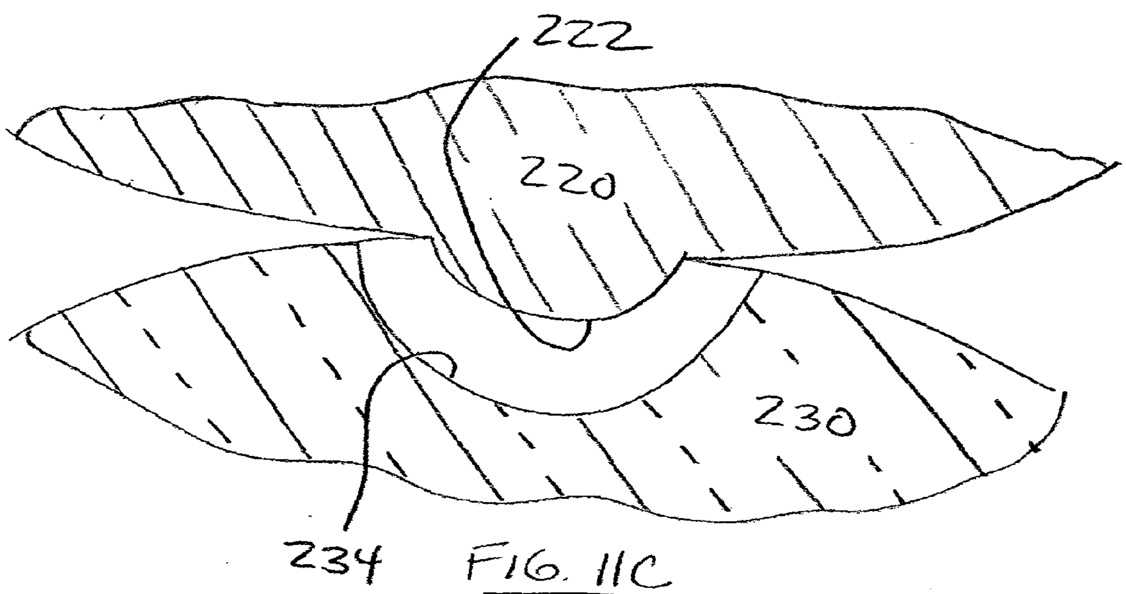


FIG. 11C

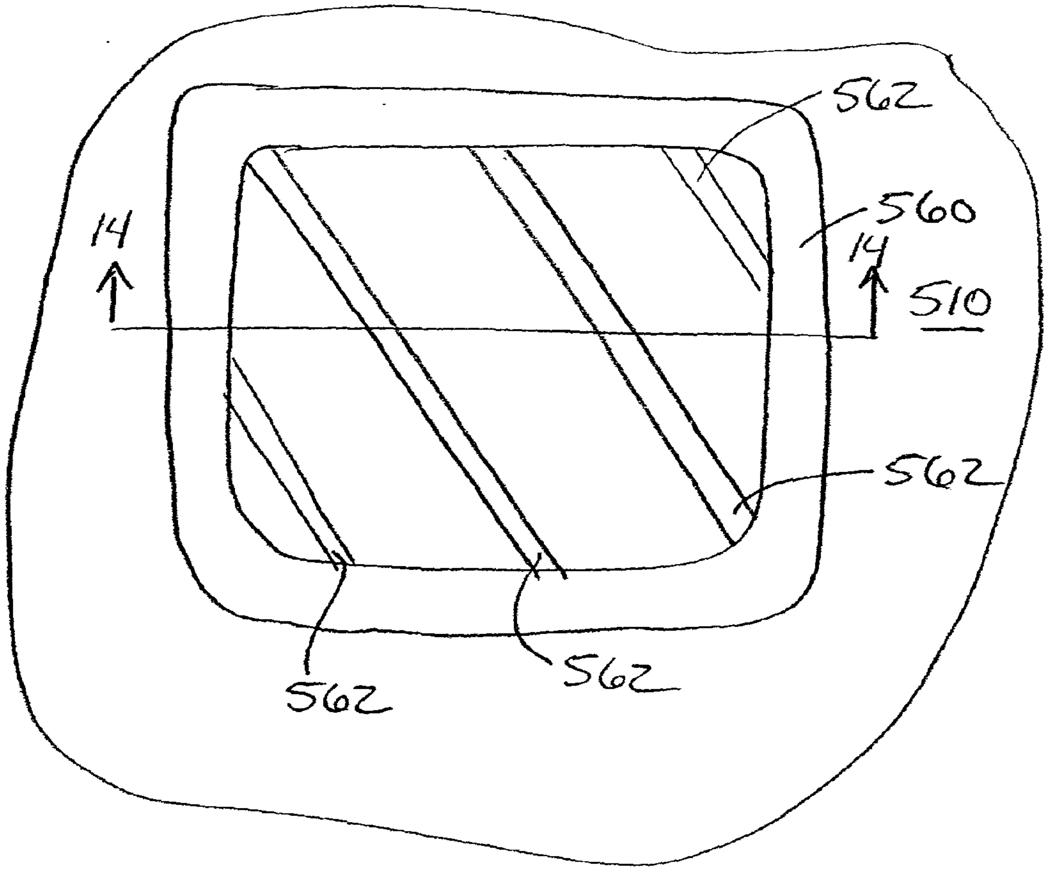


FIG. 13

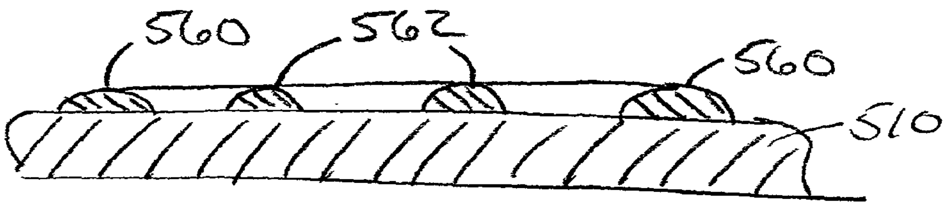


FIG. 14

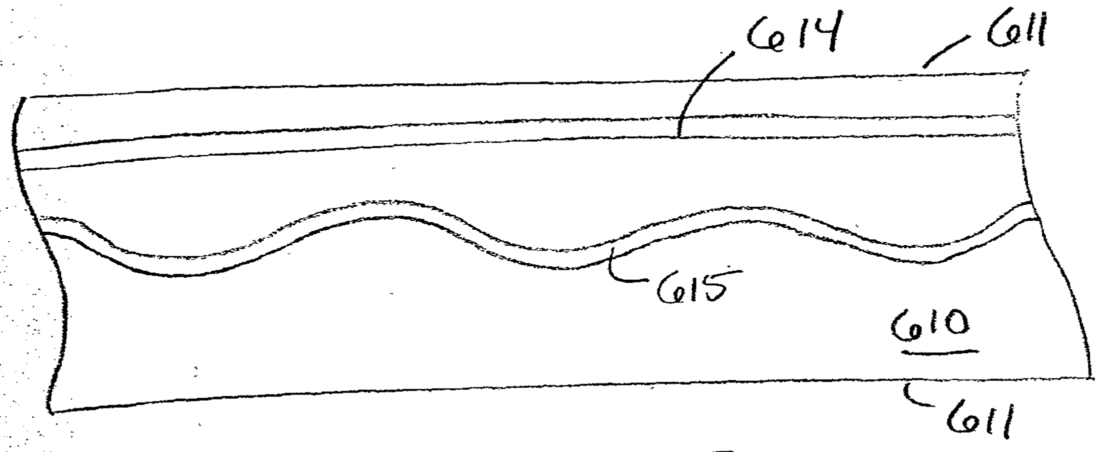


FIG. 15

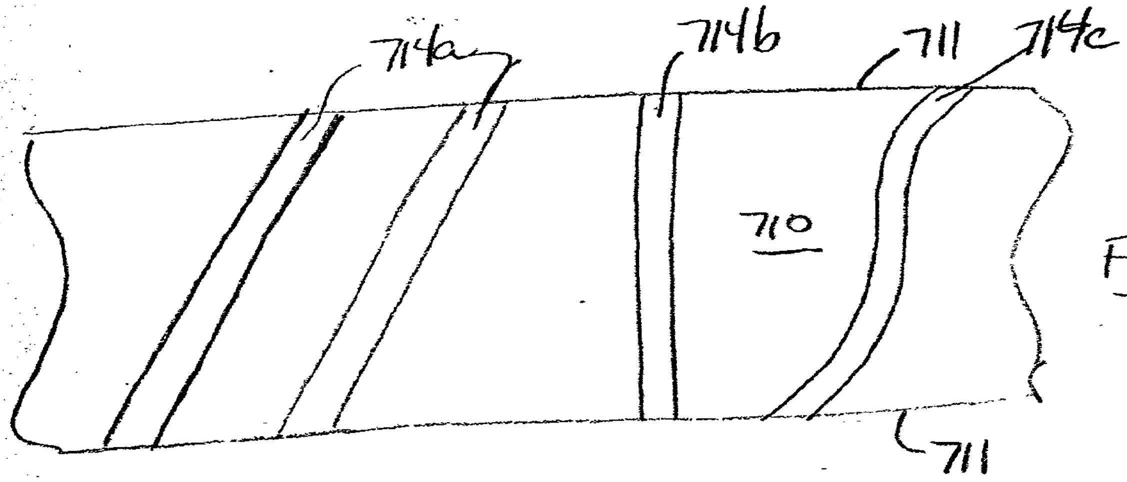


FIG. 17

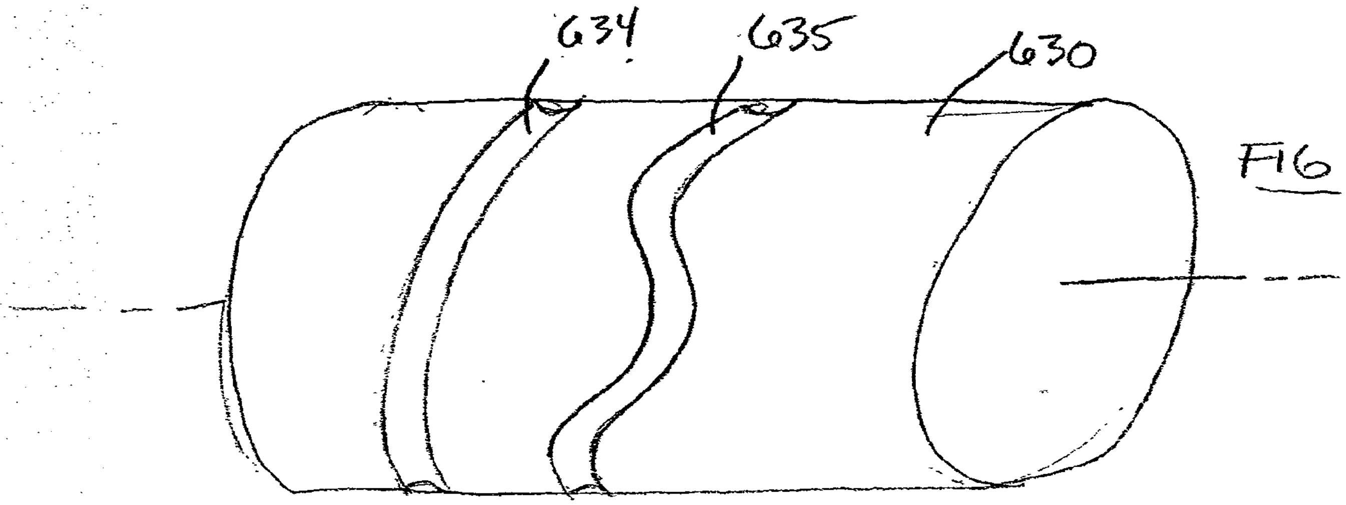


FIG 16

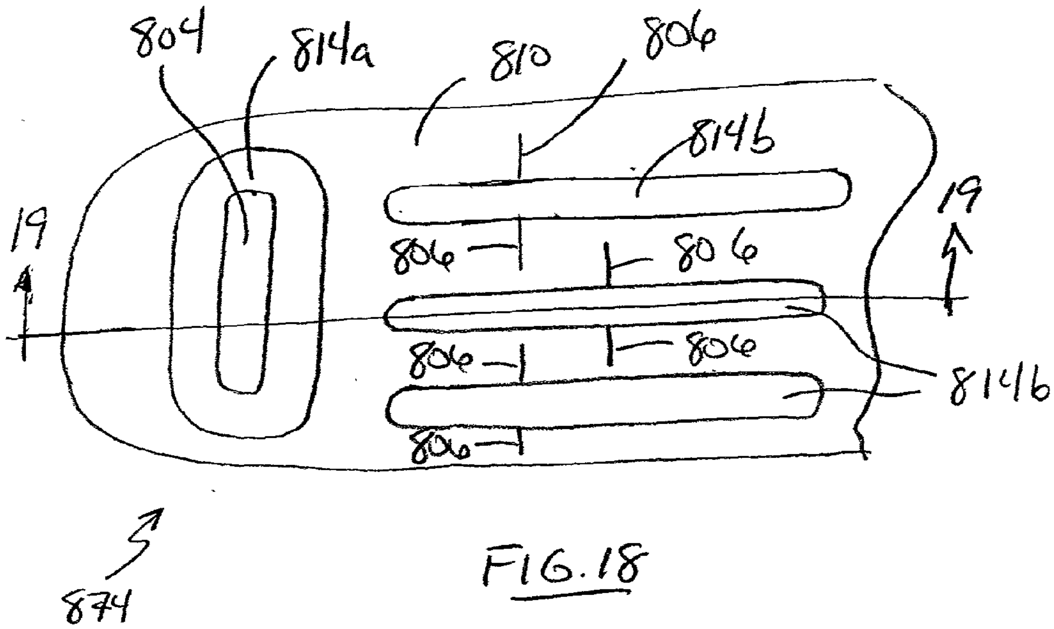


FIG. 18

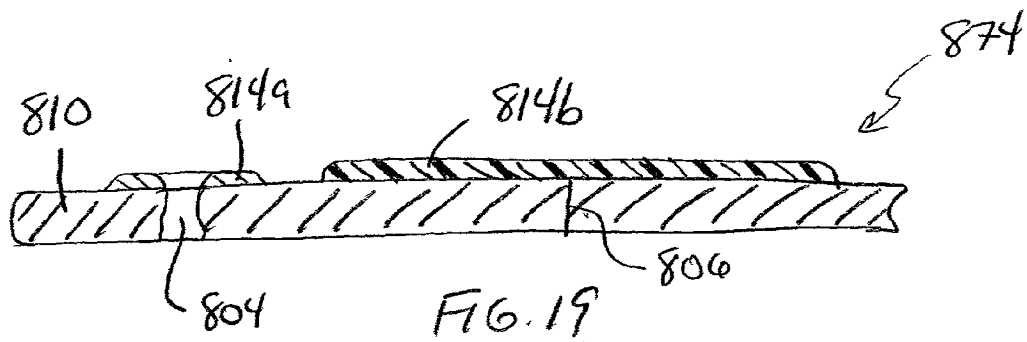


FIG. 19

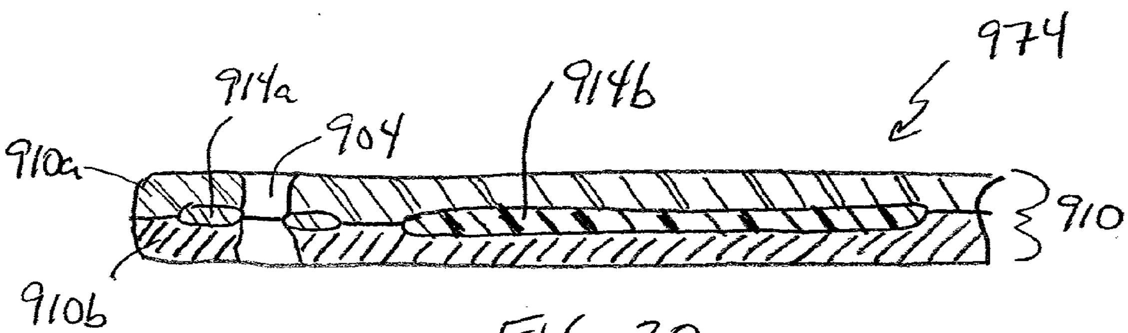


FIG. 20

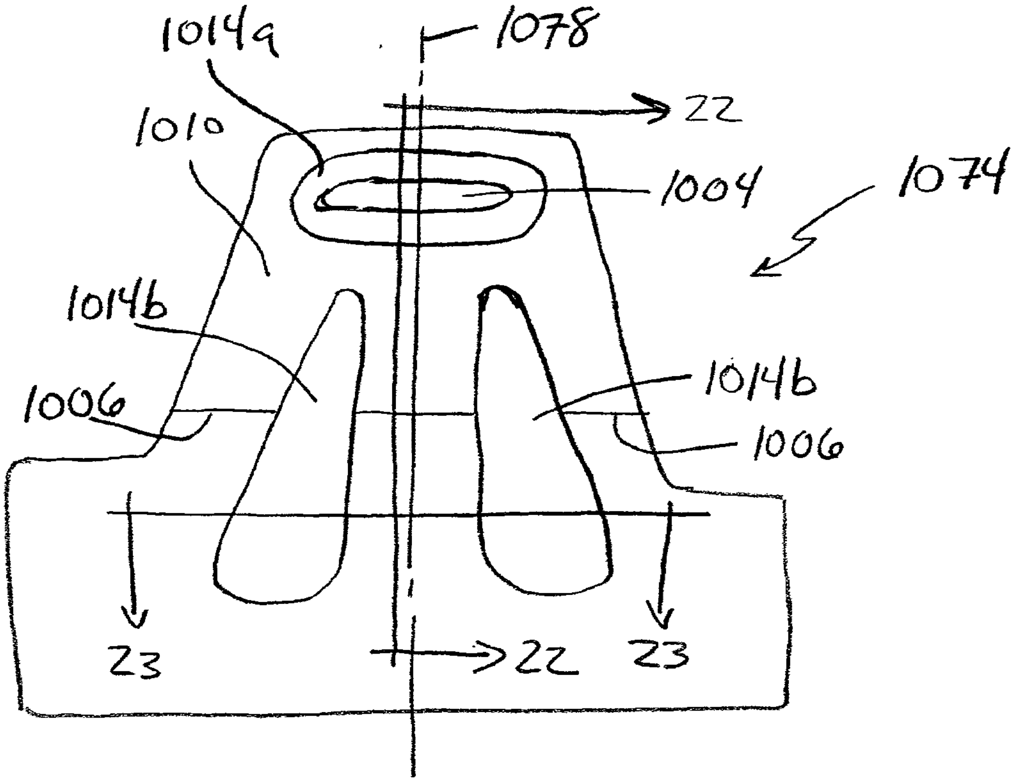


FIG. 21

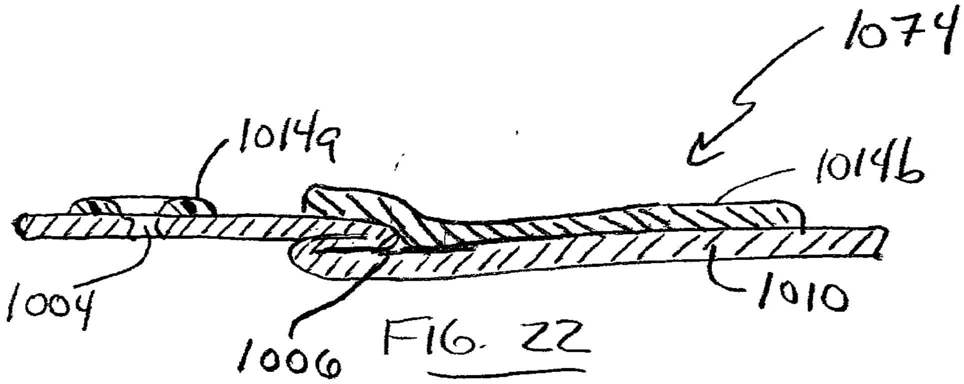


FIG. 22

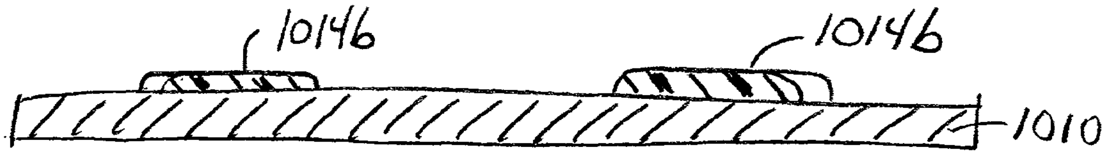


FIG. 23

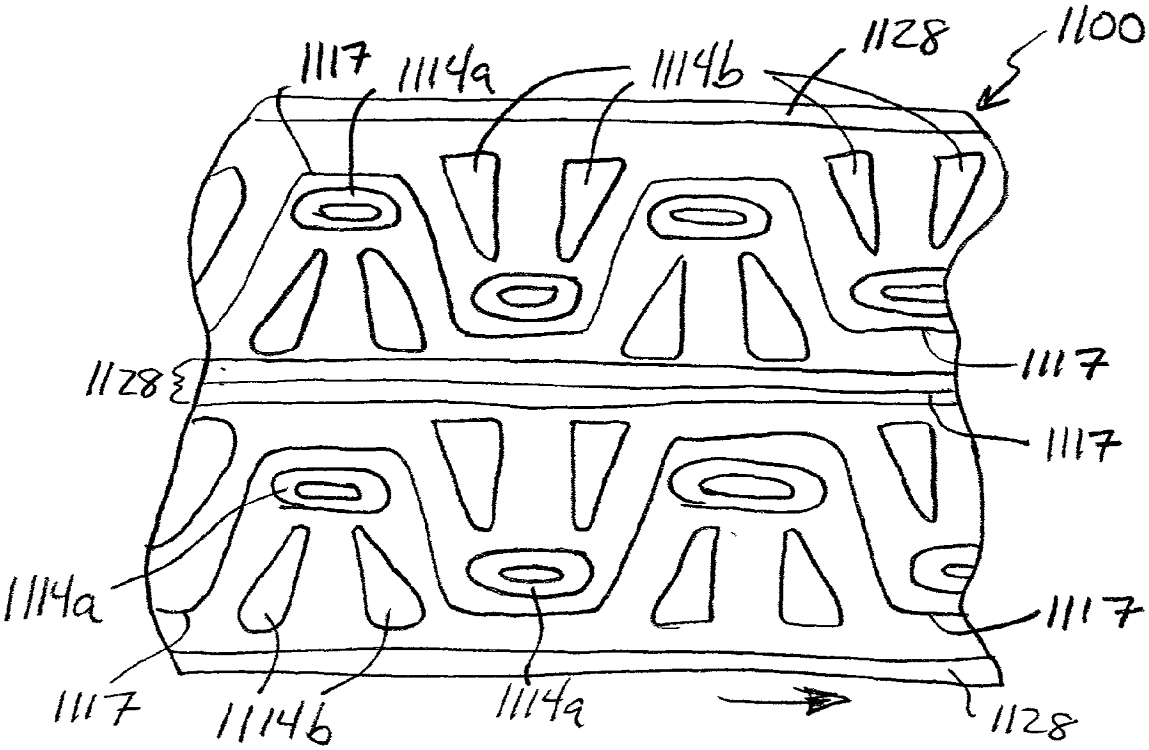

1100
1117
1114a
1114b
1128
1128
1117
1117
1114a
1117
1114b
1114a
1117
1128

FIG. 24

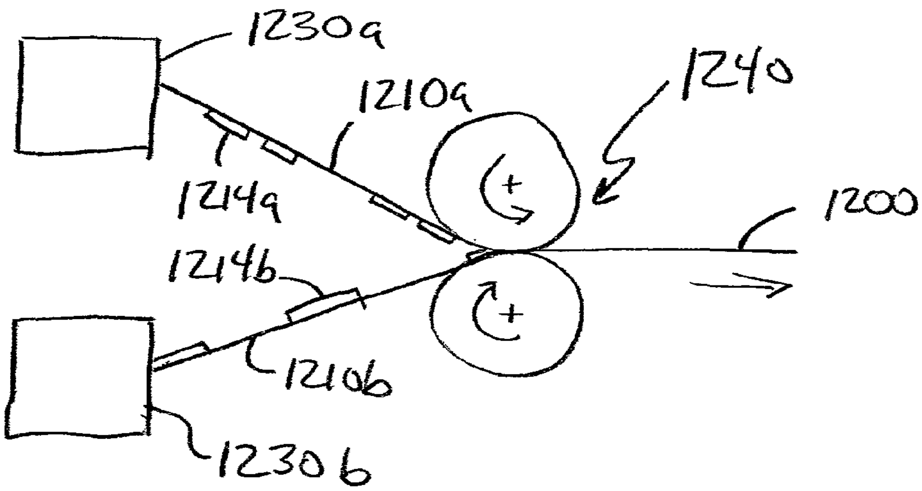

1230a
1210a
1240
1214a
1200
1214b
1210b
1230b

FIG. 25

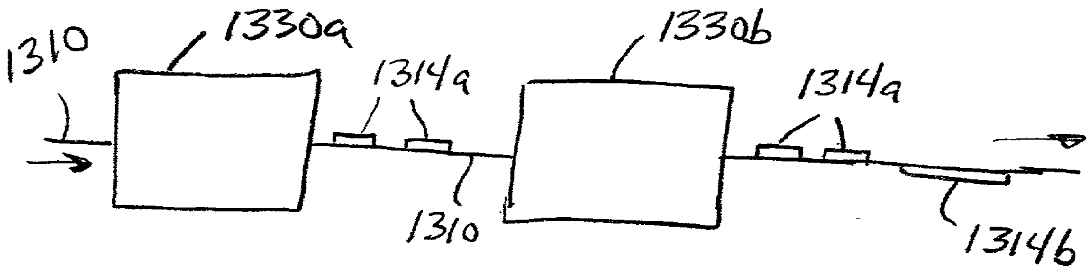


FIG. 26

BEST AVAILABLE COPY

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 2001

Application or Docket Number: 10012698

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	26	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	26 minus 20=	* 6
INDEPENDENT CLAIMS	4 minus 3 =	* 1
MULTIPLE DEPENDENT CLAIM PRESENT ☐		

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL		OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐				

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐				

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐				

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

CLAIMS ONLY

SERIAL NO.	FILING DATE
APPLICANT(S)	

CLAIMS

	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT			*		*		*	
	IND.	DEP.	IND.	DEP.	IND.	DEP.		IND.	DEP.	IND.	DEP.	IND.	DEP.
1	1						51						
2							52						
3							53						
4							54						
5							55						
6							56						
7							57						
8							58						
9							59						
10							60						
11							61						
12	1						62						
13							63						
14							64						
15							65						
16							66						
17	1						67						
18							68						
19							69						
20							70						
21							71						
22	1						72						
23							73						
24							74						
25							75						
26							76						
27							77						
28							78						
29							79						
30							80						
31							81						
32							82						
33							83						
34							84						
35							85						
36							86						
37							87						
38							88						
39							89						
40							90						
41							91						
42							92						
43							93						
44							94						
45							95						
46							96						
47							97						
48							98						
49							99						
50							100						
TOTAL IND.	4	⇩		⇩		⇩	TOTAL IND.		⇩		⇩		⇩
TOTAL DEP.	22	⇦		⇦		⇦	TOTAL DEP.		⇦		⇦		⇦
TOTAL CLAIMS	26						TOTAL CLAIMS						

**MAY BE USED FOR ADDITIONAL CLAIMS OR ADMENDMENTS*

FORM PTO-2022 (1-98)

U.S.DEPARTMENT OF COMMERCE
Patent and Trademark Office

*U.S. Government Printing Office: 1998 - 433-214/70303

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/012,698	11/05/2001		57190US002

CONFIRMATION NO. 9494

26813
MUETING, RAASCH & GEBHARDT, P.A.
P.O. BOX 581415
MINNEAPOLIS, MN 55458

FORMALITIES LETTER

OC000000007312594

Date Mailed: 01/15/2002

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $ 740 *to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).*
- Total additional claim fee(s) for this application is $192.
  - **$108** for **6 total** claims over 20.
  - **$84** for **1** independent claims over 3 .
- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(l) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.
- **The balance due by applicant is $ 1062.**

A copy of this notice MUST be returned with the reply.

Customer Service Center
Initial Patent Examination Division (703) 308-1202

PART 3 - OFFICE COPY

04 CIP 1.71

IN THE U[...]ED STATES PATENT AND TRADEMA[...] OFFICE

Applicant(s): Eaton et al. | Group Art Unit: 1771

Serial No.: 10/012,698 | Examiner: Unassigned

Filed: 05 November 2001 | Docket No.: 57190US002
Confirmation No.:9494

Title: COMPOSITE WEBS WITH REINFORCING POLYMERIC REGIONS AND ELASTIC POLYMERIC REGIONS

OIPE JC186 APR 1 2 2002 PATENT & TRADEMARK OFFICE

RECEIVED APR 15 2002 TC 1700

Assistant Commissioner for Patents
Washington, D.C. 20231

We are transmitting the following documents along with this Transmittal Sheet (which is submitted in triplicate):

X An itemized return postcard.
__ A Petition for Extension of Time for __ month(s) and a check in the amount of $___ for the required fee.
X An Information Disclosure Statement (2 pgs); copies of 5 applications; 1449 forms (3 pgs); and copies of 62 documents cited on the 1449 forms.
__ A check in the amount of $___, for __.
__ A certified copy of a __ application, Serial No. __, filed __________, the right of priority of which is claimed under 35 U.S.C. §119.
__ Other:
__ Amendment __ No Additional fee is required. __ The fee has been calculated as shown:

Fee Calculation for Claims Pending After Amendment

	Pending Claims after Amendment (1)	Claims Paid for Earlier (2)	Number of Additional Claims (1-2)	Cost per Additional Claim	Additional Fees Required
Total Claims				x $18 =	
Independent Claims				x $84 =	
One or More New Multiple Dependent Claims Presented? If Yes, Add $280 Here →					
Total Additional Claim Fees Required					

Please consider this a PETITION FOR EXTENSION OF TIME for a sufficient number of months to enter these papers and please charge any additional fees or credit overpayment to Deposit Account No. 13-4895. Triplicate copies of this sheet are enclosed.

CERTIFICATE UNDER 37 C.F.R. §1.8: The undersigned hereby certifies that this Transmittal Letter and the paper(s), as described hereinabove, are being deposited in the United States Postal Service, as first class mail, in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231, on this 9th day of April, 2002.

MUETING, RAASCH & GEBHARDT, P.A.
Customer Number: 26813

26813
PATENT TRADEMARK OFFICE

By: [signature]
Name: Kevin W. Raasch
Reg. No.: 35,651
Direct Dial: 612-305-1218
Facsimile: 612-305-1228

(LARGE ENTITY TRANSMITTAL UNDER RULE 1.8)

OIPE JC APR 12 2002 PATENT & TRADEMARK OFFICE

PATENT
Docket No. 57190US002

RECEIVED APR 15 2002 TC 1700

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	Eaton et al.	)	Group Art Unit:	1771
		)		
Serial No.:	10/012,698	)	Examiner:	Unassigned
Confirmation No.:	9494	)		
		)		
Filed:	05 November 2001	)		
		)		
For:	COMPOSITE WEBS WITH REINFORCING POLYMERIC REGIONS AND ELASTIC POLYMERIC REGIONS			

INFORMATION DISCLOSURE STATEMENT

Assistant Commissioner for Patents
Washington D.C. 20231

Sir:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with C.F.R. §§ 1.97 *et. seq.*, the materials enclosed herewith are brought to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Consideration of each of the documents listed on the attached 1449 forms is respectfully requested. Pursuant to the provisions of M.P.E.P. §609, Applicants further request that a copy of the 1449 forms, marked as being considered and initialed by the Examiner, be returned with the next Official Communication.

Applicants also wish to bring the Examiner's attention to the following pending U.S. Applications, as well as any prior art and any provisional U.S. patent applications referenced therein. A copy of each of the below-listed pending U.S. Patent Applications is provided herewith.

List of Pending Non-Published U.S. Patent Applications

Applicant(s)	Application Number	Filing Date	Serial No. of Provisional Application to which listed Application claims priority

Applicant(s): Eaton et al.
Serial No.: 10/012,698
Confirmation No.: 1330
Filed: 05 November 2001
For: SYSTEMS AND METHODS FOR COMPOSITE WEBS WITH STRUCTURED DISCRETE POLYMERIC REGIONS

Desai et al.	60/337,804	11/05/01	
Molander et al.	60/338,761	11/05/01	
Seidel et al.	10/012,894	11/05/01	PG PUB
Eaton et al.	10/012,900	11/05/01	PG PUB
Jackson et al.	10/013,304	11/06/01	PG PUB

It is believed that no fee is due, as this Information Disclosure Statement is filed prior to the receipt of any Action on the merits. However, in the event a fee is due, please charge any fee or credit any overpayment to Account No. 13-4895.

The Examiner is invited to contact Applicants' Representatives at the below-listed telephone number, if they can be of any assistance during prosecution of the present application.

CERTIFICATE UNDER 37 C.F.R. 1.8:

The undersigned hereby certifies that this paper is being deposited in the United States Postal Service, as first class mail, in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231, on this 9th day of April, 2002.

[signature]
Kevin W. Raasch

9 April, 2002
Date

Respectfully submitted for

Eaton et al.

By
Mueting, Raasch & Gebhardt, P.A.
P.O. Box 581415
Minneapolis, MN 55458-1415
Phone: (612)305-1220
Facsimile: (612)305-1228
Customer Number 26813

26813
PATENT TRADEMARK OFFICE

By: [signature]
Kevin W. Raasch
Reg. No. 35,651
Direct Dial (612)305-1218

Serial No.: 60/337,804
Filing Date: 05 November 2001
Applicants: Desai et al.
Title: VARIABLE STRETCH COMPOSITE AND METHOD OF MAKING THE COMPOSITE

VARIABLE STRETCH COMPOSITE AND METHOD OF MAKING THE COMPOSITE

FRED NAVAL DESAI
URMISH POPATLAL DALAL

FIELD OF THE INVENTION

The present invention relates to variable stretch composites having one or more elastomeric members disposed on an inelastically elongatable substrate. The composite has been incrementally stretched to break up the structure of the substrate and to reduce its resistance to stretch. The variable stretch composites are useful for disposable and durable articles, such as disposable absorbent articles including diapers, pull-on diapers, training pants, incontinence briefs, catemenial garments, baby bibs, and the like, and durable articles like garments including sportswear, outerwear and the like. The present invention also relates to methods of forming such variable stretch composites and articles containing such composites.

BACKGROUND

Disposable absorbent products like diapers, feminine pads, incontinence articles typically include stretchable materials, such as elastic strands, in the waist region and the cuff regions to provide a snug fit and a good seal of the article. Pant-type absorbent articles further include stretchable materials in the side portions for easy application and removal of the article and for sustained fit of the article. Stretchable materials have also been used in the ear portions for adjustable fit of the article.

There are various approaches to provide desirable elastic properties in those areas. Stretchable materials may be films or nonwoven fibrous webs made of elastomeric materials. Such a material would be stretchable in any direction. However, since the films or webs are made entirely of elastomeric materials, they are relatively expensive, and they tend to have more drag on skin surface, resulting in discomforts to the wearer of the article. The stretchable films may be laminated to one or more layers of nonwoven webs. Since such nonwoven webs typically are made of thermoplastic fibers, they have very limited stretchability. Consequently, the resulting laminates provide considerable resistance to stretch. It is necessary to reduce this resistance considerably in order to make functional stretch laminates.

Other approaches to make stretchable structures are also known, including: stretch-bonded laminates (SBL) and necked-bonded laminates (NBL). Stretch bonded laminates are made by stretching the elastomer in the machine direction (MD), laminating it to one or more nonwoven substrates while it is in the stretched state, and releasing the tension in the elastomer so that the nonwovens gather and take on a puckered shape. Necked-bonded laminates are made by first stretching the nonwoven substrate in the machine direction so that it necks in the cross machine direction (CD), then bonding the elastomer to the substrate while it is still in the stretched state. This laminate will be stretchable in CD, at least up to the original width of the nonwoven before it was necked. Combinations of stretch bondings and neck bondings have also been known to deliver stretch in both MD and CD direction. In these approaches, at one of the components are in a tensioned (i.e., stretched) state when the components of the laminates are joined wherein.

Zero strain stretch laminates are also known. The zero strain stretch laminates are made by bonding the elastomer to the nonwoven while both are in an unstrained state. The laminates are then incrementally stretched to impart the stretch properties. The incrementally stretched laminates are stretchable only to the extent afforded by the non-recovered (i.e., residual) extensibility of the laminate. For example, U.S. Pat. No. 5,156,793, issued to Buell et al., discloses a method for incrementally stretching the elasotmer-nonwoven laminate web, in a non-uniform manner, to impart elasticity to the resulting laminate.

In all the approaches above, stretch laminates are made separately. The stretch laminates must be cut into the appropriate size and shape, then adhesively attached to the desired location in the product in a process sometimes referred as the "cut-and-slip" process. Because of the different stretch properties required for different elements of the product, it is necessary to make a variety of laminates having different stretchability and cut the laminates to different sizes and shapes. Several cut and slip units may be needed to handle the different stretchability of the stretch laminates and to attach them to different locations of the product. As the number of cut-and-slip units and/or steps multiply, the process quickly becomes cumbersome and complicated.

Based on the foregoing, it is desirable to have a cost effective stretch composite having elastomeric materials disposed only in specific areas in specific amount for stretchability. It is also desirable to have a stretch composite having variable stretchabilities among discrete, spaced apart elements of the article. It is further desirable to have stretch composites having variable stretchability locally (i.e., within an element of the article).

Moreover, it is desirable to have a cost effective process that does not involve multi-steps and/or multi-units and that delivers variable stretch properties to various portions of the absorbent article. Such process for making the above variable stretch composites is desirable because it has total flexibility that allows for controlled deposition of different types and/or amount of elastomeric materials where they are needed. Such process is also desirable because it tailors the delivery of stretchability and resistance to stretch in various portions of a product to deliver improved fit and comfort to the wearer.

SUMMARY OF THE INVENTION

One aspect of the present invention relates to a variable stretch composite comprising an inelastically elongatable fibrous web; a plurality of first elastomeric members disposed on a first region of the web; and a plurality of second elastomeric members disposed on a second region of the web. The first and the second elastomeric members may penetrate at least partially into the substrate. The substrate and the elastomeric members have been incrementally stretched such that the substrate is permanently elongated. The first and the second elastomeric members are different in one or more properties, including elasticity, melt viscosity, add-on level, shape, pattern, composition, and combinations thereof.

In another aspect of the invention, the variable stretch composite may be made by the process comprising the steps of: providing an inelastically elongatable fibrous substrate; applying a first precursor material in a fluid state either directly or indirectly to at least a portion of the substrate to form a first elastomeric member; applying a second precursor material in a fluid state to at least a portion of the substrate to form a second elastomeric member; forming a composite preform; and incrementally stretching the composite preform to permanently elongate the substrate in at least one direction; wherein the first and the second elastomeric members are different in one or more of the following properties: elasticity, melt viscosity, shape, pattern, add-on level, composition, and combinations thereof.

The variable stretch composite may be used for portions of an absorbent article to provide desired benefits including better fit, improved comfort, lower forces to put on and/or take off. The portions of the absorbent article that desire stretchability typically include, but are not limited to, the waist region, the leg cuffs, side portions, ear portions, and fastener tabs.

It is also within the scope of the present invention that multiple elastomeric members may be disposed on the substrate in overlapping regions. It is further within the scope of the present invention that each elastomeric member may be different from its neighboring elastomeric members in one or more of the following properties: elasticity, melt viscosity, shape, pattern, add-on level, composition, and combinations thereof. Additionally, it is within the scope of the present invention to include a second substrate at least partially joined to the first substrate in a facing relationship to sandwich the elastomeric members between the substrates.

BRIEF DESCRIPTION SHOWN IN THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the present invention, it is believed that the invention will be more fully understood from the following description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a perspective view of one embodiment of a disposable absorbent article of the present invention;

Figure 2 is a schematic illustration of a process of the present invention providing the impregnated elastomeric members into the substrate;

Figure 2b is a schematic illustration of a secondary operation of the present invention which uses interengaging forming rolls to incrementally stretching the composite preform;

Figure 3 is a fragmentary perspective view of a pair of closely-spaced forming rolls each having alternating and interengaging peripheral teeth and grooves; and

Figure 4 an enlarged fragmentary cross-sectional view showing the tip portions of the interengaging forming toll teeth with a web material positioned between the rolls and spanning and in contact with the tips of adjacent teeth.

DETAILED DESCRIPTION OF THE INVENTION

The term "disposable" refers herein to describe products which generally are not intended to be laundered or otherwise restored or extensively reused in their original function, i.e., preferably they are intended to be discarded after about 10 uses or after about 5 uses or after about a single use. It is preferred that such disposable articles be recycled, composted or otherwise disposed of in an environmentally compatible manner.

The term "durable" refers herein to describe products which generally are intended to be laundered or otherwise restored or extensively reused in their original function, i.e., preferably they are intended to be used more than about 10 times.

The term "disposable absorbent article" refers herein to a device that normally absorbs and retains fluids. In certain instances, the phrase refers to devices that are placed against or in proximity to the body of the wearer to absorb and contain the excreta and/or exudates discharged from the body, and includes such personal care articles as fastened diapers, pull-on diapers, training pants, swim diapers, adult incontinence articles, feminine hygiene articles, and the like. In other instances, the phrase refers to protective or hygiene articles, for example, bibs, wipes, bandages, wraps, wound dressings, surgical drapes, and the like.

The term "breathable" refers herein to describe materials that are permeable and transmittable to vapor and/or gas.

The term "web" refers herein to any continuous material, including a film, a non-woven fabric, a woven fabric, a foam or a combination thereof, or a dry lap material including wood pulp, and the like, having a single layer or multiple layers.

The term "substrate" refers herein to any material, including a film, a non-woven fabric, a woven fabric, a foam or a combination thereof, or a dry lap material including wood pulp, and the like, having a single layer or multiple layers, and suitable for printing a polymeric material on at least one surface of the "substrate."

The term "fibrous substrate" refers herein to a material comprised of a multiplicity of fibers that could be either a natural or synthetic material or any combination thereof. For example, nonwoven materials, woven materials, knitted materials, celluloid materials, and any combinations thereof.

The term "non-woven" refers herein to a fabric made from continuous filaments and/or discontinuous fibers, without weaving or knitting by processes such as spun-bonding, carding and melt-blowing. The non-woven fabric can comprise one or more non-woven layers, wherein each layer can include continuous filaments or discontinuous fibers. Non-woven can also comprise bi-component filaments, which can have shell/core, or side by side structure.

The term "elastomer" refers herein to a polymer exhibiting elastic properties.

The term "elastic" or "elastomeric" refers herein to any material that upon application of a biasing force, can stretch to its elongated length, which is at least about 150 percent of its relaxed, original length, without rupture and breakage, and upon release of the applied force, can recover substantially to its original length. For example, when an elastic material is stretched to 160 percent of its relaxed original length, it recovers substantially, the recovered length being no more than 105 percent of the relaxed original length.

The term "inelastic" refers herein to any material that does not fall within the definition of "elastic" above.

The term "inelastically elongatable" refers herein to any material that upon application of a biasing force to stretch beyond about 110 percent of its relaxed original length will exhibit permanent deformation, including elongation, rupture, breakage, and other defects in its structure, and/or changes in its tensile properties.

The variable stretch composite of the present invention comprises one or more elastomeric members disposed on and at least partially penetrate a region of an inelastically elongatable fibrous substrate that has been permanently elongated. Different elastomeric members can be disposed on different regions of the substrate to deliver different properties, especially different elasticity. The variable stretch composite can be made in situ as a portion of an article by the present process to form a desired article having a stretch laminate therein. The in-situ process eliminates additional processing steps, such as cutting, shaping, and bonding. In the process of the present invention, the expensive elastomeric material is used efficiently by delivering one or more elastomeric members to the article only where they are needed and in the amount needed. Further, the resulting product made with the laminate and the process disclosed herein can provide improved product fit and comfort.

The elastomeric members can have varied shapes and profiles in any direction, which result in desired variations in physical properties of the composite material within the elastomeric members. The planar shape in the x-y direction of the elastomeric members can be any suitable geometrical shape defining the planar dimensions of the composite material, including a rectilinear outline, a curvilinear outline, a triangle, a trapezoid, a square, a parallelogram, a polygon, an ellipse, a circle, and any combination thereof. The contour profile in the z direction of the elastomeric members can be any suitable geometric shape including linear and nonlinear profiles. The variation in the dimension in the z direction across the x-y plane can also be achieved by the process of the present invention.

The variable physical properties may include tensile strength, elastic modulus, elasticity, conductivity, breathability (i.e., vapor and/or gas permeability), liquid impermeability, and others. Further, unique interrelationships between physical properties can be formed, for example the ratio of modulus to density, tensile strength to density, and others providing cost benefits of the new composite material.

Figure 1 illustrates one embodiment of an absorbent article, at least a portion of the article comprises the variable stretch laminate of the present invention. For ease of understanding, much of the following description will be made in terms of a disposable diaper 10. The diaper 10 can comprise a plurality of elastomeric members on a substrate, typically a nonwoven fibrous web, of the diaper 10 to provide specific functions for the diaper 10. These elastomeric members may include leg elastic 12 for gasketing function around the legs of the wearer; waist elastic 14 for gasketing function around the waist; elasticized ear portion 16 and elasticized side panel portion 15 for adjustable fit function around the torso; fastener system 18 which may include a slot member 20 and tab member 22 for fastening function that provides closure for the diaper 10; and elasticized member 26 over outercover 24 for adjustable fit function directed mainly to tummy, buttocks and the crotch areas and for adjusting the breathable function provided by the outercover 24.

The manufacture of these elastic elements of a diaper typically include the step of cutting from an elastomeric material (in the form of a film, a fibrous web, a laminate of film and fibrous web) to the desired size and shape, then joining the discrete pieces of elastomeric materials to the substrate using known bonding methods such as adhesive bonding. In contrast, the present invention provides a novel process that combines the step of making of elastomeric members and the step of joining the elastomeric members to a substrate into a single step continuous process. Moreover, in the present invention, the elastomeric members can be applied directly onto multiple regions, corresponding to discrete elements of the diaper, such as waist elastic, leg elastics, etc., of an absorbent article in one continuous application process. The present invention is well suited to deliver different elasticity to meet the different requirements of individual elements of the diaper. It is also contemplated by the present invention that multiple elastomeric members having different elasticities may be applied in adjacent regions on a single element of an absorbent article. The different elasticities may be achieved by variations in melt viscosities, shapes, patterns, add-on levels, compositions, and combinations thereof.

In the present invention, the precursor material of the elastomeric member is processed in a fluid state, typically having a viscosity of less than about 150 Pa· s (at 150°C and 1 s^{-1}). The precursor material may at least partially penetrate the substrate in order to achieve sufficient bonding between the resulting elastomeric member and the substrate so that they do not delaminate in the incremental stretching step. The selective depositing of precursor materials uses less elastomeric materials than the amount would be required by the conventional lamination technology. The fibrous substrate can provide the resulting composite material with lighter weight and higher breathability than a polymeric sheet. The fibrous substrate can further provide a soft, cloth-like feel to the skin for better wearer comfort.

One or more elastomeric members may be applied directly to the fibrous web, or indirectly transferred to the fibrous web by first deposited onto an intermediate surface. Suitable methods for application may include contact methods such as gravure printing, intaglio printing, flexography printing, slot coating, curtain coating, and the like; and non-contact methods such as ink jet printing, spraying, and the like. Each application method operates in a specific viscosity range, thus, a careful selection of the viscosity of the elastomeric precursor material is required. Composition, temperature and/or concentration can be varies to provide the suitable viscosity at processing condition.

Temperature may be raised to lower the viscosity of the precursor material. However, the higher temperature may have adverse effect on the stability of the fibrous web substrate which may experience partial or local thermal degradation at regions the heated precursor material is deposited. A balance between these two effects is desirable. Alternatively, indirect/transfer methods may be used. The precursor material is heated to achieve a suitable viscosity for processing and applied to an intermediate surface (e.g., a carrier substrate) having good thermal stability, which is then transferred to the fibrous substrate to form the composite preform. The indirect/transfer method allows for a wider operating temperature because the heated precursor material is at least partially cooled when it contacts the fibrous substrate. Nip pressure may be applied with the help of calendar rolls to get sufficient penetration and bonding.

Alternatively, the composition of the precursor material may comprise low molecular weight elastomers, elastomeric precursors and optionally crosslinkers, or combinations thereof, such that the composition would have the suitable viscosity at processing condition and desired elasticity in the finished composite. Such elastomeric compositions may be subjected to post-treatments to achieve the desired elasticity and other properties including strength, modulus, and the like. Typically, post-treatments include drying, crosslinking, curing or polymerizing via chemical, thermal, radiation means, and combinations thereof.

The non-contacting methods allow for more flexible processing conditions and/or broader processing window. Since the application equipment is not in direct contact with the substrate, there is less insult on the structural integrity of the substrate. Thus, fibrous webs having lower basis weight, or lower mechanical strength can be used as the substrate. The non-contact methods are especially desirable for high speed processes where direct contact between the equipment and the substrate can apply substantial shear and-abrasive forces on the substrate, possibly causing damages to the surface and/or the structure of the substrate. The non-contact methods also allow substrates with lower thermal stability to be used since the fluid precursor materials may be partially air-cooled before coming into contact with the substrate. Nip pressure may also be applied, if necessary, in the non-contact process.

In one embodiment of the present invention, a rotogravure printing process is used because it provides flexibility in desired x-y-z dimensions of the elastomeric member and desired quantity of deposition of the precursor material. Gravure printing process includes direct and indirect (or off-set) methods. The direct gravure printing process deposits the precursor material directly onto the substrate. The indirect or off-set gravure printing process first deposits the precursor material onto an offset roll or a carrier surface and then transfers it to the substrate. In the indirect process, the precursor material may be partially cooled and even partially solidified when it finally contacts the substrate. Thus, the indirect process may be useful for substrates that are thermally sensitive or unstable, such as nonwoven webs, or substrates of low melting polymers, including polyethylene and polypropylene. Moreover, the off-set gravure printing process provides a wider temperature range for the process, even when a low thermal stability substrate is used.

In another embodiment, the ink jet printing process is used because it provides total flexibility in the shapes and/or patterns of the elastomeric members without retooling the printing head.

The elastomeric members may be applied in various shapes or patterns continuously or intermittently. Typically, the elastomeric members may be applied in stripes, curvilinear shapes, spirals, discrete dots and the like. The elastomeric members may also be applied in various geometric or decorative shapes or figures. The various patterns may place the elastomeric members in parallel and/or angled positions with respect to one another, or with respect to components of the diaper, such as leg openings, waist openings, side seams. For example, parallel stripes can be applied in one direction, or two sets of parallel stripes can be applied in two different directions to give a cross-hatch or a scrim pattern.

The substrate material may be films, woven fibrous webs or nonwoven fibrous webs. When the precursor material is applied in its fluid state to a fibrous nonwoven substrate, it may penetrate into the open structure of the fibrous web to be advantageously bonded with the nonwoven substrate. It is desirable to have partial penetration sufficient to form such bonding so that the resulting composite preform does not delaminate in the incremental stretching process. The degree of penetration may be affected by several factors: the viscosity of the precursor material when in contact with the substrate, the porosity of the substrate, the surface tension between the substrate and the precursor material. For example, the indirect gravure printing process may limit the amount of penetration by partially cooling the precursor material to lower its viscosity, hence its mobility, before it contacts the fibrous substrate. In another example, the deposited precursor material may be cooled further by blowing chilled air/gas onto to it prior to or while coming into contact with the substrate. In another example, the degree of penetration may be enhanced by applying pressure by passing the substrate/precursor material through a pair of nip rolls. The nip rolls may be heated or chilled, which affects the viscosity of the precursor material, to provide further control of the degree of penetration. The elastomer can also be deposited onto the substrate with standard equipment used for glue application like spraying, slot coating, curtain coating, etc. In one embodiment, spraying may be done by using equipment for spiral spray or meltblown fibrous deposits. In another embodiment, a specific equipment for spraying may be used to achieve deposits of uniform fiber distribution and shape (UFD Omega, available from ITW Dynatec, Hendersonville, TN). Multiple nozzles can be used in parallel (i.e. in CD) and in series (i.e. in the MD) to vary the type and amount of elastomer that is deposited in different areas of the elastic member. Variable stretch properties can be achieved in several different ways. In one embodiment, the gravure printing method is used, whereby it is possible to vary the local stretch properties by varying the amount of elastomer deposited in different regions of an element of the absorbent article. This may be accomplished by changing the gravure pattern in the x and y directions, for example, making the strands thicker in one area and thinner in another area, or by varying the strand density. Furthermore, two or more gravure rolls, with different elastomer in each, can also be used to deposit these elastomers in different regions of the element.

In another embodiment, spraying method may be used to deliver variable stretch properties. The suitable spraying equipment may include multiple nozzles arranged in series and in parallel, and the nozzles may apply the same or different precursor materials. These nozzles can be controlled so that they start and stop at well defined times to give any desired stretch property in any area.

Furthermore, it is also possible to combine different deposition processes, for example gravure printing with spraying, to obtain the desired properties in the resulting stretch composites.

The local stretch property can be varied in different ways. It can be varied discretely in which the property changes in a stepwise manner. An example of such stepwise change would be to apply a high performance elastomer in one region of an element of the diaper (such as the top part of an ear portion) and a lower performance elastomer in another region of that element (such as the lower part of the ear portion) where the stretch requirements are less demanding. The stretch property can also be varied continuously, either linearly or non-linearly. The continuous changes in stretch properties may be achieved by a gravure pattern designed in such a way that the cell depth decreases gradually along the circumference of the roll, thus resulting in a printed pattern where the amount of deposited elastomer decreases continuously in the machine direction.

The precursor material may have a melt viscosity of from about 1 to about 150 Pa· s, preferably from about 5 to about 100 Pa· s, and more preferably from about 10 to about 80 Pa· s, at 150°C and 1 s^{-1} shear rate.

The elastomeric members may be applied to a specific region to achieve a total add-on level of from about 5 to about 200 g/m2, preferably from about 20 to about 150 g/m2, and more preferably from about 50 to about 100 g/m2. Thus, the first and the second regions may have open areas not covered by elastomeric members raging from about 10% to about 80% of the total surface area of the region, preferably from about 20% to about 70%, and more preferably from about 40% to about 60%.

Since each region may have a different number of elastomeric members disposed per unit area, the add-on level per elastomeric member also differs from region to region. Thus, when comparing a first region having first elastomeric members disposed thereon and a second region having second elastomeric members disposed thereon, the ratio of the add-on level on the basis of individual first and second elastomeric member, may range from about 1.05 to about 3, preferably from about 1.2 to about 2.5, and more preferably from about 1.5 to about 2.2.

Further, the first and the second elastomeric members may have an elasticity ratio of from about 1.1 to about 3.0, preferably from about 1.2 to about 2.5, and more preferably from about 1.5 to about 2.2. This elasticity is measured on a solid, cast elastomeric film. Elasticity is defined as the force at 100 % strain during the loading cycle in the hysteresis test.

The above variable stretch composite materials can be manufactured by process 50 of the present invention, one embodiment of which is illustrated schematically in Figure 2. As shown in Figure 2, a fibrous substrate 36 is provided by a supply roll 52 and moves through a rotogravure printing device 54 that deposits the precursor material for elastomeric members 60 onto the fibrous substrate 36. The precursor material being in a fluid state, may at least partially penetrate the fibrous substrate 36 to form a composite preform 37. Optionally, a second fibrous substrate 34 may be provided by a supply roll 56 and combined with the substrate 36 to sandwich the elastomeric member 60 between them to form a composite preform 37.

The composite preform may be subjected to additional treatments such as drying, cooling, consolidating (e.g., passing between a pair of nip rolls 58), crosslinking, and/or curing (e.g., via chemical, thermal, radiation methods).

The elastic properties of the leg elastic 12, the waist elastic 14, and the side panel portion 15 can be provided by various secondary operations, including incremental stretching of the composite preform 37 to permanently elongate the fibrous substrate, enabling the elastomeric member to stretch within the provided elongation of the substrate. Alternatively, prior to depositing the elastomeric member, the fibrous substrates can be strained to consolidate the fibrous substrate in the cross direction, which after deposition of the elastomeric member, can expand under a force in the cross direction to enable the elastomeric member to stretch within the provided expansion of the substrate.

A process sometimes referred to as "ring-rolling," may be a desirable incremental stretching operation of the present invention. In the ring rolling process, corrugated interengaging rolls are used to permanently elongate the fibrous substrate to reduce its resistance to stretch. The resulting composite has a greater degree of stretchability in the regions that have been subjected to the ring rolling process. Thus, this secondary operation provides additional flexibility in achieving stretch properties in localized, targeted regions of the variable stretch composite.

Alternatively, the secondary operation may employ a pair of interengaging grooved plates applied to the composite preform under pressure to achieve incremental stretching of the composite preform in localized regions.

To achieve the desired stretchability in the variable stretch composites, it is desirable that the fibrous substrate is permanently elongated such that the resulting fibrous substrate has a peak tensile strength of less than about 40%, preferably less than about 30% and more preferably less than about 20% of its original peak tensile strength before being permanently elongated. Such permanently elongated fibrous substrates provide little resistance to stretch. It is not necessary that the fibrous substrate provide structural integrity in the targeted stretch regions since the elastomeric members disposed thereon provide the structural integrity and the stretchability. The resulting variable stretch composite may have an elastic force ranging from about 20 g/in to about 1000 g/in, preferably from about 50 g/in to about 750 g/in, and more preferably from about 100g/in to about 500 g/in, as measured at 100% strain. This force at 100 % strain is referred to herein as the "elasticity" or the "elastic force".

Methods for imparting stretchability to an otherwise substantially inelastic material by using corrugated interengaging rolls which laterally or longitudinally stretch and permanently deform the material are disclosed in U. S. Patent No. 4,116,892, issued on September 26, 1978, to E. C. A. Schwarz; U. S. Patent No. 4,834,741, issued on May 30, 1989, to R. N. Sabee; U.S.

Patent No. 5,143,679, issued on September 1, 1992 to G. M. Weber et al.; U.S. Patent No. 5,156,793, issued on October 20, 1992, to K. B. Buell et al.; U. S. Patent No. 5,167,897, issued on December 1, 1992 to G. M. Webber et al.; and U. S. Patent No. 5,422,172, issued on June 6, 1995, to P.-C. Wu; and U.S. Patent No. 5,518,801, issued on May 21, 1996 to C. W. Chappell et al. Each of these patents are hereby incorporated by reference.

In one embodiment, the ring rolling process is incorporated into process 50 as a secondary operation, which includes a set of forming rolls 108 and 109 positioned between printing device 54 and take up roll 46. Referring to Figure 2b, composite preform 37 is fed to the nip 107 formed by a pair of opposed forming rolls 108 and 109 that together define a forming station 106. Exemplary structure and relative positions of forming rolls 108, 109 are shown in an enlarged perspective view in Figure 3. As shown, rolls 108 and 109 are carried on respective rotatable shafts 121, 123, having their axes of rotation disposed in parallel relationship. Each of rolls 108 and 109 includes a plurality of axially-spaced, side-by-side, circumferentially-extending, equally-configured teeth 122 that can be in the form of thin fins of substantially rectangular cross section, or they can have a triangular or an inverted V-shape when viewed in cross section. The outermost tips of the teeth are preferably rounded to avoid cuts or tears in the materials that pass between the rolls.

The spaces between adjacent teeth 122 define recessed, circumferentially-extending, equally configured grooves 124. The grooves can be of substantially rectangular cross section when the teeth are of substantially rectangular cross section, and they can be of inverted triangular cross section when the teeth are of triangular cross section. Thus, each of forming rolls 108 and 109 includes a plurality of spaced teeth 122 and alternating grooves 124 between each pair of adjacent teeth. The teeth and the grooves need not each be of the same width, however, and preferably the grooves have a larger width than that of the teeth, to permit the material that passes between the interengaged rolls to be received within the respective grooves and to be locally stretched, as will be explained hereinafter.

Figure 4 is an enlarged view of several interengaged teeth 122 and grooves 124 with a composite preform being modified therebetween. As shown, a portion of composite preform 37, is received between the interengaged teeth and grooves of the respective rolls. The interengagement of the teeth and grooves of the rolls causes laterally spaced portions of composite preform 37 to be pressed by teeth 122 into opposed grooves 124. In the course of passing between the forming rolls, the forces of teeth 122 pressing composite preform 37 into opposed grooves 124 impose within composite preform 37 tensile stresses that act in the cross-web direction. The tensile stresses cause intermediate sections 126 that lie between and that span the spaces between the tips 128 of adjacent teeth 122 to stretch or extend in a cross-web direction, which results in a localized reduction of the web thickness as well as web tensile strength at each of intermediate web sections 126.

The action of pressing of portions of composite preform 37 into the respective grooves 124 by teeth 122 therefore causes a non-uniform reduction of the thickness of composite preform 37 to take place in the cross-web direction of the composite. The thickness of portions 128 that are in contact with the tooth tips reduces only slightly, comparing to the thickness reduction of intermediate portions 126 that span adjacent teeth 122. Thus, by passing through the interengaged rolls and being locally laterally stretched at spaced intervals between adjacent teeth, the inelastic elongatable fibrous web develops alternating heavy and light basis weight regions. The light basis weight regions are found at the positions of the web wherein the web material has been locally laterally stretched. Additional cross-web stretching of the exiting, formed web can be effected by passing the modified web between so-called Mount Hope rolls, tentering frames, angled idlers, angled nips, and the like (not shown), each of which is known to those skilled in the art.

Alternatively, other process embodiments of the present invention can include the use of multiple deposition devices to provide multiple depositions of elastomeric materials onto one or more substrates, including deposition onto two substrates separately and then combing them, and/or making several subsequent depositions onto the same substrate. Further, the use of multiple deposition devices can provide a greater deposition weight of the elastomeric material, a greater z dimension profile variation, capability to deposit different elastomeric materials, and capability to deposit elastomeric materials of different colors, and any combinations thereof.

In one embodiment, the outer cover 24 of the diaper 10 shown in Figure 1 includes an elastomeric member 26 to provide desired breathability of the outer cover 24 while maintaining liquid impermeability of the outer cover 24. Multiple elastomeric members 26 may be disposed on the outer cover 24 with various orientations. For example, multiple elastomeric members 26 may be disposed parallel to, perpendicular to, or at an angle to the waist opening or the leg openings, and each elastomeric member may have different orientation from neighboring elastomeric members.

In another embodiment, the waist elastic 14 of the diaper 10 shown in Figure 1 includes an elastomeric member 28 to provide desired elasticity of the waist 14 providing desired comfort, gasketing, and sustained fit. The elastic property of the waist elastic 14 can be provided by a variety of thermoplastic elastomeric resins providing elastic properties across the elastomeric member. In one embodiment of the present invention the elastomeric member 28 can be manufactured from KRATON® styrenic block copolymer, available from Shell Corporation, that is at least partially impregnated into a High Elongation Carded polypropylene nonwoven manufactured by BBA Nonwovens Inc. of South Carolina having a basis weight of about 22 grams/meter^2. The resulting composite material can provide elastic force at 100% strain from about 400 grams/inch to about 1000 grams/inch. The width 46 of the elastomeric member 28 perpendicular to the direction of stretch forces can vary from about 2mm to about 200mm and the thickness of the elastomeric member 28 can vary from about 30 microns to 300 microns, wherein a greater degree of elastic force can be provided in areas of greater width and/or thickness. For example, in the back waist area 40 of the diaper 10 where a greater elastic force can be desired, the thickness and/or width of the elastomeric member 28 can be greater than in other areas of the waist 14.

In another embodiment, the leg elastic 12 of the diaper 10 shown in Figure 1 includes a elastomeric member 42 to provide desired elasticity of the leg elastic 12 providing desired comfort and gasketing. The elastic property of the leg elastic 12 can be provided by a variety of thermoplastic elastomeric resins providing elastic properties across the elastomeric member. In one embodiment of the present invention, the elastomeric member 42 can be manufactured from KRATON® styrenic block copolymer available from Shell Corporation, that is at least partially impregnated into a High Elongation Carded polypropylene nonwoven manufactured by BBA Nonowovens Inc. of South Carolina, having a basis weight of about 22 grams/meter^2. The resulting composite material can provide elastic force at 100% strain from about 50 grams/inch to about 100 grams/inch. The width of the elastomeric member 42 perpendicular to the direction of stretch forces can vary from about 2mm to about 20mm and the thickness of the elastomeric member 42 can vary from about 30 microns to 150 microns, wherein a greater degree of elastic force can be provided in areas of greater width and/or thickness. For example, in the back leg area 44 of the diaper 10 where a greater elastic force can be desired, the thickness and/or width of the elastomeric member 42 can be greater than in other areas of the leg elastic 12.

In a further embodiment, the elastic side panel 15 of the diaper 10 shown in Figure 1 includes elastomeric member 17 to provide desired elasticity of the elastic side panel 15 providing desired comfort and sustained fit. The elastic property of the elastic side panel 15 can be provided by a variety of thermoplastic elastomeric resins providing elastic properties across the elastomeric member. In one embodiment of the present invention the elastomeric member 17 can be manufactured from KRATON styrenic block copolymer available from Shell Corporation, that is at least partially impregnated into a High Elongation Carded polypropylene nonwoven manufactured by BBA Nonwovens Inc. of South Carolina, having a basis weight of about 22 grams/meter^2. The resulting composite material can provide elastic force at 100% strain from about 100 grams/inch to about 500 grams/inch. The width of the elastomeric member 17 perpendicular to the direction of stretch forces can vary from about 2mm to about 200mm and the thickness of the elastomeric member 17 can vary from about 30 microns to 300 microns, wherein a greater degree of elastic force can be provided in areas of greater width and/or thickness. For example, in the waist direction of the elastic side panel 15 of the diaper 10 where a greater elastic force can be desired, the thickness and/or width of the elastomeric member 17 can be greater than in the leg direction of elastic side panel 15.

TEST METHODS

Shear Viscosity Test

Shear viscosity of precursor materials can be measured using the RDA II Viscometer (manufactured by Rheometrics) or the AR 1000 Viscometer (manufactured by TA Instruments) in the parallel plate mode. In this test, the sample is placed between two parallel plates that are 25 mm in diameter and have a gap of 1.5 mm between them. The sample chamber is heated to and maintained at 150 °C. Shear viscosity is measured at shear rate of 1 s^{-1}. The % strain can be selected in such a way that the torque measurement is within the operating range of the instrument.

Simple Tensile Test for the Substrate

This test is used to measure the peak tensile strength of the inelastic substrate before and after it has been subjected to incremental stretching. This test is done on the substrate only, without the elastomeric member.

Sample Preparation by Incremental Stretching

The inelastic substrate is subjected to incremental stretching by pressing it between two interengaging grooved plates, one stationary and the other movable. The plates are at least 4" x 4" in dimension and are made of stainless steel. The setup is such that the movable plate can move in and out of the grooves of the fixed plate, while maintaining good alignment, i.e. the tooth tip of one plate precisely engages in the corresponding valley of the other plate. In this setup, the pitch, which is the distance between adjacent teeth on a plate, is 1.524 mm, tooth height is 10.31 mm, and the tooth tip radius is 0.102 mm. Depth of engagement (DOE), which is the distance between two adjacent tooth tips from two teeth on different plates, refers to how deeply the teeth are engaged. In this test, the DOE is 3.639 mm.

A 4" x 8" sample of the substrate is attached to the stationary plate using adhesive tape in such a way that the tape is not present in the region where the sample is incrementally stretched. Incremental stretching needs to be done in the desired direction of stretching. The movable plate is engaged with the stationary plate at a speed of 1.82 m/s and is then returned to its original position. The incrementally stretched sample is then removed from the stationary plate and cut to appropriate size for tensile testing.

Tensile Strength Measurement

A commercial tensile tester from Instron Engineering Corp., Canton, MA or SINTECH-MTS Systems Corporation, Eden Prairie, MN may be used for this test. A 1" wide x 3" long sample is cut in such a way that the long dimension is in the desired direction of stretch. Since the substrate would have been weakened upon incremental stretching, it may be difficult to cut the 1" X 3" sample accurately, especially in the direction of stretching. However, it would not affect the result much, since the only useful output would be the peak tensile strength, which is more or less independent of initial gauge length. The instrument is interfaced with a computer for controlling the test speed and other test parameters, and for collecting, calculating and reporting the data. The tensile properties are measured at room temperature (about 20°C). The procedure is as follows:

(1) choose appropriate jaws and load cell for the test; the jaws should be wide enough to fit the sample, typically 1" wide jaws are used; the load cell is chosen so that the tensile response from the sample tested will be between 25% and 75% of the capacity of the load cells or the load range used, typically a 50 lb load cell is used;
(2) calibrate the instrument according to the manufacture's instructions;
(3) set the gauge length at 1";
(4) place the sample in the flat surface of the jaws according to the manufacture's instructions;
(5) set the cross head speed at a constant speed of 10"/min;
(6) start the test and collect load versus strain data simultaneously; and
(7) calculate and report peak tensile strength (in units of g/in).

The average result of three samples is reported.

Hysteresis Test

This test is used to measure the stretch properties of the elastomeric member (solid elastomeric film without the substrate) and the stretch composite region (elastomeric members and substrate in a region, after incremental stretching). Force at 100 % strain in a loading cycle is referred to as the "elasticity".

Sample Preparation for the Elastomeric Member

In this test, different elastomeric members are made in the form of solid, cast films. About 5 gm of the precursor material is sandwiched between two silicone-coated release films and is heated and pressed with the help of a heated Carver press (hand press). Temperatures and pressures will vary depending on the type of elastomer that is cast. Shims of 0.010" thickness are used to obtain uniform film thickness. Desired pressure is applied for r a minute or so, after which the pressure is released and the film is allowed to cool down. In some cases, it may be necessary to post treat the film, for example crosslink it, to make it elastomeric. The film is then cut in the required dimensions for the hysteresis test.

Hysteresis Protocol

A commercial tensile tester from Instron Engineering Corp., Canton, MA or SINTECH-MTS Systems Corporation, Eden Prairie, MN may be used for this test. A sample 1" wide by 3" long is cut in such a way that the long dimension is in the desired direction of stretch. The instrument is interfaced with a computer for controlling the test speed and other test parameters, and for collecting, calculating and reporting the data. The hysteresis is measured at room temperature. The procedure is as follows:

(1) choose appropriate jaws and load cell for the test; the jaws should be wide enough to fit the sample, typically 1"wide jaws are used; the load cells is chosen so that the response from the sample tested will be between 25% and 75% of the capacity of the load cells or the load range used, typically a 50 lb load cell is used;

(2) calibrate the instrument according to the manufacture's instructions;

(3) set the gauge length at 1";

(4) place the sample in the flat surface of the jaws according to the manufacture's instructions;

(5) set the cross head speed at a constant rate of 10"/min;

(6) start the hysteresis test and collect data simultaneously, the hysteresis test has the following steps:

a) go to 100% strain in the loading cycle at a constant rate of 10"/min;

b) hold position for 30 seconds;

c) return to 0% strain in the unloading cycle at a constant rate of 10"/min;

(7) calculate and report load at 100% strain in the loading cycle. In this patent, this load at 100% strain is referred to as the "elasticity" and is a measure of the elasticity of the material. The elastomer needs to meet the definition of an elastic material as specified in the "description" section. The average result of three samples is reported in g/in.

While particular embodiments and/or individual features 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. Further, it should be apparent that all combinations of such embodiments and features are possible and can result in preferred executions of the invention. Therefore, the appended claims are intended to cover all such changes and modifications that are within the scope of this invention.

WHAT IS CLAIMED IS:

1. A process for making a variable stretch composite comprising the steps of:

(a) providing a first inelastically elongatable fibrous substrate;

(b) applying a first precursor material in a fluid state either directly or indirectly to a first region of the substrate to form one or more first elastomeric members;

(c) applying a second precursor material in a fluid state either directly or indirectly to a second region of the substrate, to form one or more second elastomeric members;

(d) forming a composite preform; and

(e) incrementally stretching the composite preform to permanently elongate the substrate in at least one direction;

wherein the first and the second elastomeric members are different in one or more of the following properties: elasticity, melt viscosity, shape, pattern, add-on level, and composition.

2. The process of claim 1 wherein step (d) comprises crosslinking, curing, drying, cooling, consolidating, and combinations thereof.

3. The process of claim 1 wherein the permanently elongated substrate has a peak tensile strength at least about 40% lower than the peak tensile strength of the substrate before being permanently elongated.

4. The process of claim 1 wherein a ratio of the elasticity of the first elastomeric member to the elasticity of the second elastomeric member ranges from about 1.1 to about 3.0.

5. The process of claim 1 wherein a ratio of the add-on level of the first elastomeric member to the add-on level of the second elastomeric member ranges from about 1.05 to about 3.0.

6. The process of claim 1 wherein the first and the second regions have a total add-on level of elastomeric members ranging from about 5 to about 200 g/m2.

7. The process of claim 1 wherein the first and the second regions have open areas ranging from about 10% to about 80% of the total area of the region.

8. The process of claim1 wherein the first and the second regions of the composite have an elasticity ranging from about 25g/in to about 1000 g/in .
9. The process of claim 1 wherein the first and the second precursor materials have a viscosity ranging from about 1 to about 150 Pa· s. measured at 150^{o}C and 1 s^{-1}.

10. The process of claim 1 further comprising a step. after step (c). of joining a second substrate to the first substrate in a facing relationship to sandwich the elastomeric members in between the substrates.

11. A variable stretch composite comprising:

an inelastically elongatable fibrous substrate having

a plurality of first elastomeric members disposed on a first region;

a plurality of second elastomeric members disposed on a second region;

the first and the second elastomeric members penetrate at least partially into the substrate; the substrate and the elastomeric members have been incrementally stretched such that the substrate is permanently elongated;

wherein the first and the second elastomeric members are different in one or more of the following properties: elasticity. melt viscosity. shape. pattern. add-on level. and composition..

12. The composite of claim 11 wherein the permanently elongated substrate has a peak tensile strength at least about 40% lower than the peak tensile strength of the substrate before being permanently elongated.

13. The composite of claim 11 wherein a ratio of the elasticity of the first elastomeric member to the elasticity of the second elastomeric member ranges from about 1.1 to about 3.0.

14. The composite of claim 11 wherein a ratio of the add-on level of the first elastomeric member to the add-on level of the second elastomeric member ranges from about 1.05 to about 3.0.

15. The composite of claim 11 wherein the first and the second regions have a total add-on level of elastomeric members ranging from about 5 to about 200 g/m2.

16. The composite of claim 11 wherein the first and the second regions have open areas ranging from about 10% to about 80% of the total area of the region.

17. The composite of claim 11, wherein the first and the second regions of the composite have an elasticity of from about 20 g/in to about 1000 g/in.

18. The composite of claim 11 wherein the elastomeric members are made from precursor materials having melt viscosities of from about 1 to about 150 Pa· s, measured at 150°C and 1 s^{-1}.

19. The composite of claim 11 wherein the composite further comprises a second substrate in facing relationship with the first substrate such that the elastomeric members are sandwiched between the substrates.

20. The composite of claim 11 wherein the composite comprises at least a portion of an absorbent article.

21. The composite of claim 19 wherein the portion of the absorbent article is a waist region, a leg cuff, a side portion, an ear portion, or a fastener tab.

ABSTRACT

The present invention relates to variable stretch composites having one or more elastomeric members disposed on an inelastically elongatable fibrous substrate. The composite has been incrementally stretched to break up the structure of the substrate and to reduce its resistance to stretch. The variable stretch composites are useful for disposable and durable articles, such as disposable absorbent articles including diapers, pull-on diapers, training pants, incontinence briefs, catemenial garments, baby bibs, and the like, and durable articles like garments including sportswear, outerwear and the like. The present invention also relates to methods of forming such variable stretch composites and articles containing such composites.

1/4

Figure 1

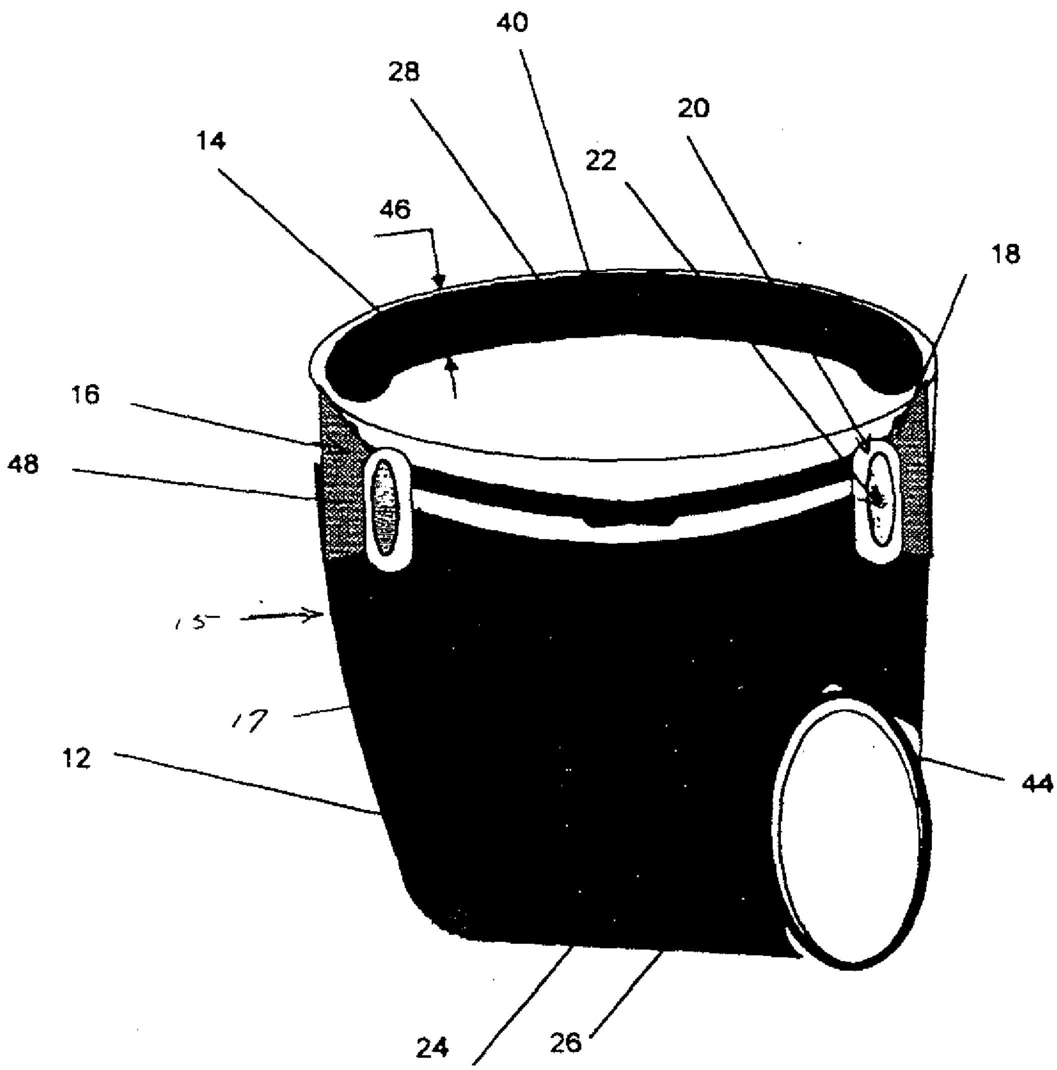
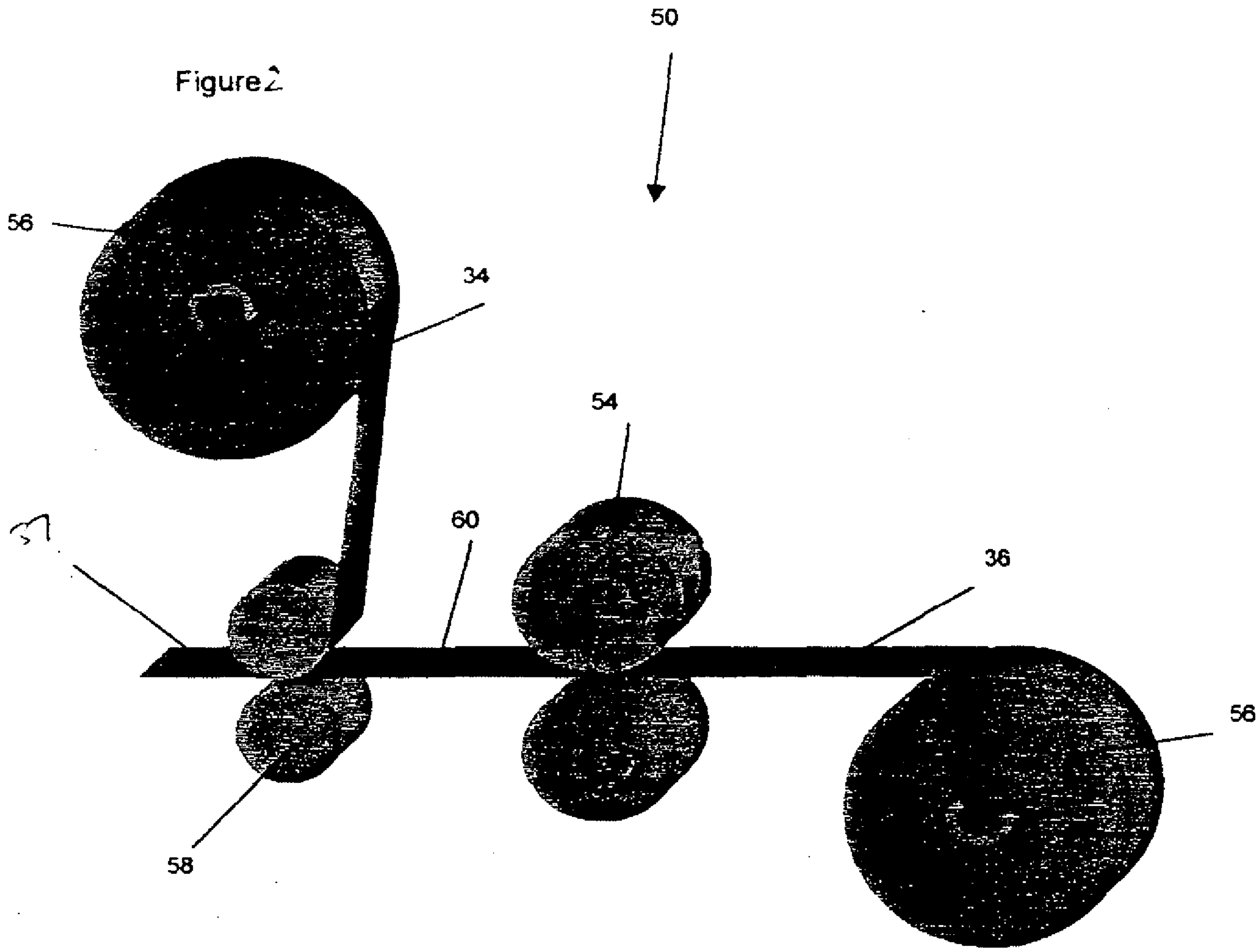


Figure 2



3/4

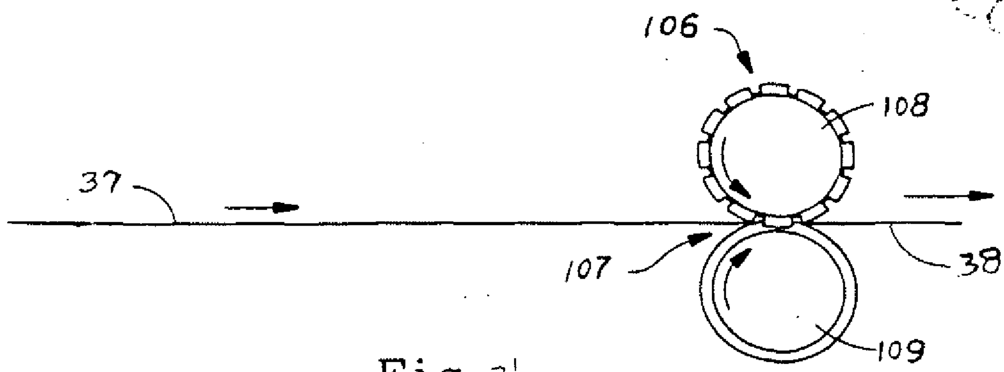


Fig. 2b

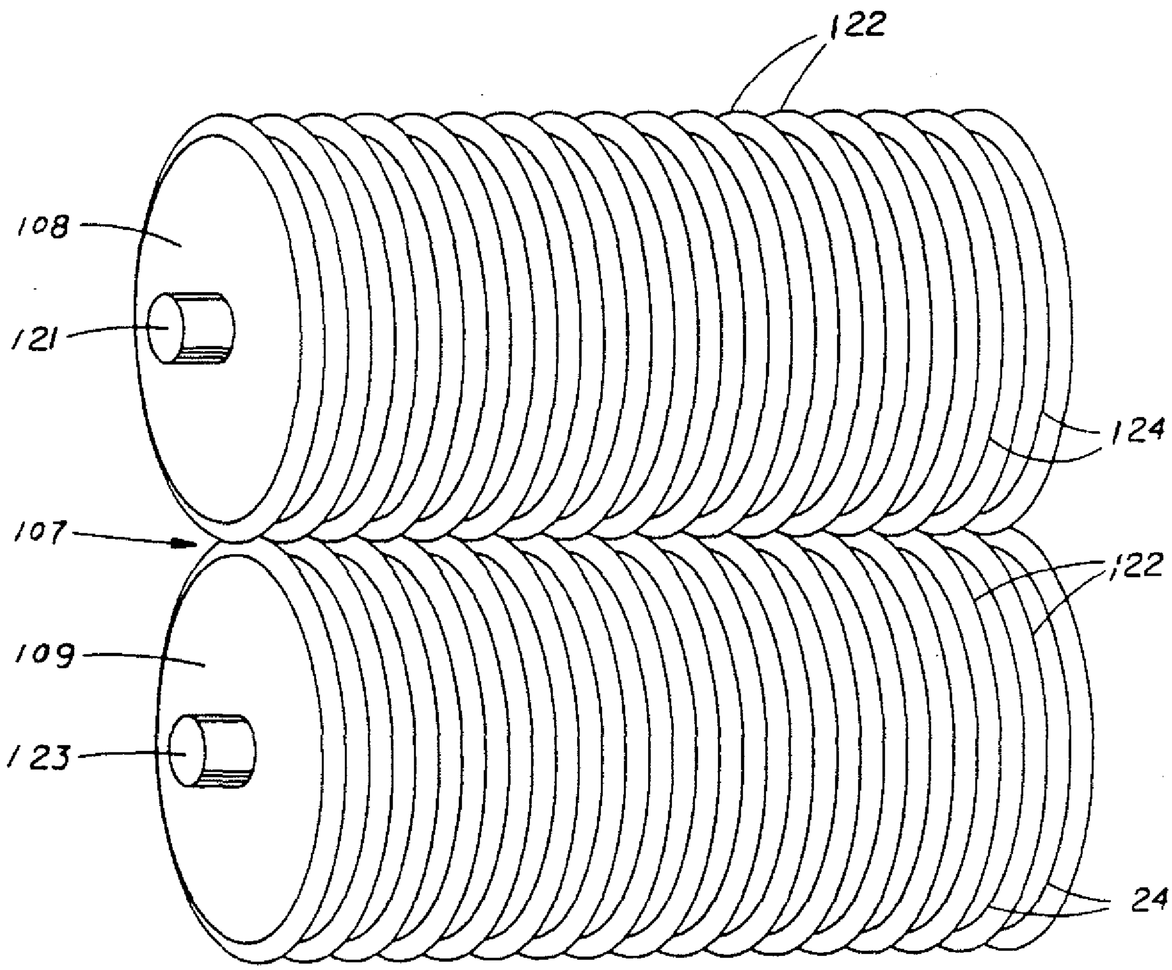


Fig. 3

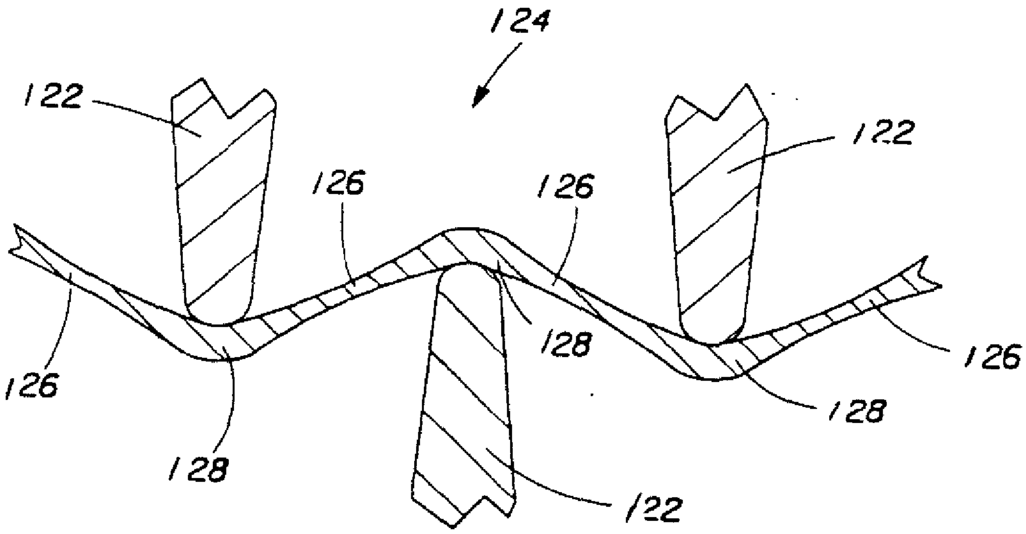


Fig. 4

Serial No.: 60/338,761
Filing Date: 05 November 2001
Applicants: Molander et al.
Title: ARTICLES COMPRISING IMPREGNATED THERMOPLASTIC MEMBERS AND METHOD OF MANUFACTURING THE ARTICLES

Case 8769P

ARTICLES COMPRISING IMPREGNATED THERMOPLASTIC MEMBERS AND METHOD OF MANUFACTURING THE ARTICLES

JOHN MOLANDER
DAVID WALLACK
JOSEPH LAM
FRED DESAI
URMISH DALAL
MARK KLINE

FIELD OF THE INVENTION

The present invention relates to disposable and durable articles, such as disposable absorbent articles including diapers, pull-on diapers, incontinence briefs, feminine hygiene garments, baby bibs, and the like, and durable articles like garments including sportswear, outerwear and the like, which comprise one or more impregnated thermoplastic members of polymeric materials to provide desired properties, and a method for manufacturing the article.

BACKGROUND

Disposable and durable articles require many specific material properties needed to provide desired performance functions, which are difficult to provide using conventional methods of manufacture. For example, disposable absorbent articles, such as diapers, have many designs providing desired product performance in collecting and retaining urine and BM without leaking outside the diaper. These functions need to be performed together with other functions in providing certain comfort to the wearer or user of the diaper during application, wear and discharge of the diaper. Comfort can be affected by effective functions of collecting and separating the exudates from the skin of the wearer, by providing a good initial fit of the diaper around the wearer and maintaining the fit during the use so the diaper does not sag and leak when becomes loaded with exudates.

Good fit can be provided by creating elasticized areas in certain locations around the diaper. Examples of such elasticized areas include elasticized leg cuffs, elasticized waist strips, elasticized side panels, and others. The desired elastic properties in such areas are normally provided by various techniques, which include creating a composite material by laminating thermoplastic elastic materials to nonwoven substrates. Such elastic materials typically include an elastic film, single or multiple elastic strands, an elastic scrim, and the like attached to a nonwoven substrate by an adhesive or mechanical bond. Such practice is expensive because it generally needs more elastic material and/or adhesive materials to bond the laminates. Further, these elastic materials require secondary operations to cut, bond, and handle these materials. These operations often incur the cost of trim and/or scrap. Therefore, it would be beneficial to provide a material, which comprises less mass of elastic material and which does not require the use of secondary operations. Further it would be beneficial to provide a material having varying degrees of elasticity in desired areas of the product. For example, profiled elastic side panels, profiled elastic waists, and profiled leg elastic cuffs providing both comfort and sustained fit.

Further, a certain degree of comfort during the wear and use can be generally provided by vapor permeability of the diaper outercover. For this, the diaper can be designed to have breathable but liquid impervious elasticized cuffs around the legs, breathable elasticized waist, breathable elasticized side panels, and breathable but liquid-impervious backing layer of the diaper. This is generally accomplished by laminating thermoplastic materials like porous or nonporous film, or scrims, or strands to a nonwoven substrate. Again as above, this approach incurs more cost for thermoplastic materials and secondary material operations. One important attribute of breathability is providing a varying degree of breathability in desired areas of the article. This is difficult and expensive to accomplish in utilizing the lamination technology. Therefore, it would be beneficial to provide a material having a varying degree of breathability comprising less mass of thermoplastic material and which does not require the secondary operations.

Further, a disposable diaper that provides functions of collecting and retaining urine and BM without leakage outside the diaper requires a fastening system to allow for desired closure of the article around torso of the wearer. Examples of fastening systems include hook -and- loop members and adhesive tape systems, which require substantial mass of thermoplastic material to provide desired material physical properties such as strength and stiffness. Another example of a fastening system includes the slot and tab fastener requiring specific shape or configuration, which is difficult to provide utilizing the lamination technology. Therefore it would be beneficial to provide a material of the desired shape comprising less mass of thermoplastic material and does not require the secondary operations such as die cutting, bonding, and trim removal.

Further, the fastening systems require varying degrees of stiffness and strength for both functional and comfort purposes. This is difficult to accomplish using the lamination technology because, as above, it requires more thermoplastic material and secondary operations. Therefore, it would be beneficial to provide a material having variable degree of stiffness and strength in specific areas comprising less mass of thermoplastic material and which does not require the secondary operations such as die cutting, bonding, and trim removal.

Further, the comfort of the wearer is affected by the surface texture of the material contacting the skin of the wearer and/or caregiver, as well as aesthetic appearance of the material itself. This is difficult to accomplish using the lamination technology. In addition, it requires additional thermoplastic materials and secondary operations to mask the undesirable properties of material surfaces. For example, an outer cover, which comprises a nonwoven web laminated to the outer surface of a thermoplastic film, provides a cloth like appearance of the outer cover. Another example includes tapes comprising a nonwoven web laminated to the outer surface of a thermoplastic film to provide a cloth like appearance. Therefore, it would be beneficial to provide a material having a desired surface texture and aesthetic appearance comprising less mass of thermoplastic material and which does not require the secondary operations.

With respect to durable articles, the desired material properties such as elasticity, breathability, stiffness, strength and the like are difficult to provide using conventional manufacturing techniques including sewing, ultrasonic welding, and the like of expensive fabrics needed to provide the desired properties. As disclosed above, these techniques require more material (thermoplastic and others) and secondary operations associated with cutting, sewing, and assembling. Therefore, it would be beneficial to substitute the expensive materials with less expensive materials comprising impregnated thermoplastic members having the desired properties and to reduce the secondary operations associated with cutting, handling, sewing, and bonding of durable articles.

SUMMARY OF THE INVENTION

In response to the difficulties and problems discussed above, a new article and a process for producing thereof have been discovered.

In one aspect, the present invention concerns an article including one or more shaped thermoplastic members at least partially impregnated into one or more fibrous substrates forming a composite material, wherein the shaped thermoplastic members have a profiled thickness providing variation in material properties, and wherein a percent variation of the profiled thickness of the thermoplastic member can vary from about 5% to about 100%.

In another aspect, the present invention concerns a method of making a composite material including at least one shaped thermoplastic member impregnated into at least one fibrous substrate, the method comprising the steps of:

a) providing a first fibrous substrate;
b) depositing a first thermoplastic material on the first fibrous substrate to form at least one shaped thermoplastic member having a profiled thickness providing variation in material properties, wherein a percent variation of the profiled thickness of the thermoplastic member can vary from about 5% to about 100%, and wherein the step of depositing is selected from a group consisting of gravure printing, screen printing, ink jet printing, and flexographic printing;
c) providing a second substrate; and
d) combining the first substrate and the second substrate to form the composite material, wherein the thermoplastic member is at least partially impregnated into the first substrate.

BRIEF DESCRIPTION SHOWN IN THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the present invention, it is believed that the invention will be more fully understood from the following description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a perspective view of one embodiment of a disposable absorbent article of the present invention;

Figure 2 is a magnified view of one embodiment of an impregnated thermoplastic member of the present invention;

Figure 3 is a cross sectional view of the impregnated thermoplastic member shown in Figure 2 taken along line 3-3;

Figure 4 is a cross sectional view of the impregnated thermoplastic member shown in Figure 2 taken along line 4-4;

Figure 5 is a simplified illustration of a process of the present invention providing the impregnated thermoplastic members into the substrate; and

Figure 6 is a magnified view of a printing cylinder pattern of the process shown in Figure 5.

DETAILED DESCRIPTION OF THE INVENTION

The article and the method of manufacture of the present invention can provide a surprising improvement in cost by reducing the need for thermoplastic materials and secondary process operations associated with cutting, forming, and bonding these materials to form a desired product. The article includes new composite materials comprising at least one thermoplastic member at least partially impregnated in one or more fibrous substrates of the article.

The impregnated thermoplastic members can have various basis weights and three dimensional shapes and profiles, which result in desired variations in physical properties of the composite material within the thermoplastic members. The planer shape in the x-y direction of the impregnated thermoplastic members can be any suitable geometrical shape defining the planer dimensions of the composite material, including a rectilinear outline, a curvilinear outline, a triangle, a trapezoid, a square, a parallelogram, a polygon, an ellipse, a circle, and any combination thereof. The contour shape in the z direction of the impregnated thermoplastic members can be any suitable geometric shape including linear and nonlinear profiles. The variation in the dimension in the z direction across the x-y plane can be from 0% to 100%, wherein this variation is calculated by the following formula:

Percent variation = 100 x (maximum thickness - minimum thickness)/maximum thickness.

The new composite materials can have various material properties within the planer dimensions of the composite material, which can vary according to the 0% to 100% variation in material thickness profile. The materials can include such physical properties as tensile strength, elastic modulus, elasticity, conductivity, breathability, liquid impermeability, and others. Further, unique interrelationships between physical properties can be formed, for example the ratio of modulus to density, tensile strength to density, and others providing cost benefits of the new composite material.

The basis weight profile of the impregnated thermoplastic members can be any suitable geometric shape including linear and nonlinear profiles. The variation in basis weight across the x-y plane can be from 0% to 100%, wherein this variation is calculated by the following formula:

Percent variation = 100 x (maximum basis weight - minimum basis weight)/maximum basis weight.

The new composite materials can have various material properties within the planer dimensions of the composite material, which can vary according to the 0% to 100% variation in basis weight profile. The materials can include such physical properties as tensile strength, elastic modulus, elasticity, conductivity, breathability, liquid impermeability, and others. Further, unique interrelationships between physical properties can be formed, for example the ratio of modulus to density, tensile strength to density, and others providing cost benefits of the new composite material.

Terminology

The term "article" herein includes both disposable and durable articles.

The term "disposable" is used herein to describe products which generally are not intended to be laundered or otherwise restored or extensively reused in their original function, i.e., preferably they are intended to be discarded after about 10 uses or after about 5 uses or after about a single use. It is preferred that such disposable articles be recycled, composted or otherwise disposed of in an environmentally compatible manner.

The term "durable" is used herein to describe products which generally are intended to be laundered or otherwise restored or extensively reused in their original function, i.e., preferably they are intended to be used more than about 10 times.

A "disposable absorbent article" refers herein to a device that normally absorbs and retains fluids. In certain instances, the phrase refers to devices that are placed against or in proximity to the body of the wearer to absorb and contain the excreta and/or exudates discharged from the body, and includes such personal care articles as baby diapers, baby training pants, adult incontinence articles, feminine hygiene articles, baby swim diapers, wound dressing, and the like. In other instances, the phrase refers to protective articles, such as, for example, dining bibs that have the ability to absorb food items to prevent staining of the wearer's clothing.

The term "diaper" includes baby diapers, baby training pants, baby pool diapers, or adult incontinence articles and refers to a disposable fluid-handling article generally worn by infants and other incontinent persons about the lower torso.

The term "feminine hygiene articles" refers herein to any absorbent article worn by women to absorb and contain menses and other vaginal exudates.

A "body wrap" refers herein to an article or a garment worn about the body, typically to provide some therapeutic benefit, such as, for example, pain relief, wound coverage or to hold another device or article near the body.

The term "breathable" is used herein to describe materials that are permeable and transmittable to vapor, wherein the vapor transmission rate is measured in grams per 24 hours.

The term "material" refers herein to any web, substrate, fibrous material, woven, nonwoven, knitted, film, a component of a garment or an absorbent article.

The term "web" is meant herein any continuous material, including a film, a non-woven fabric, a woven fabric, a foam or a combination thereof, or a dry lap material including wood pulp, and the like, having a single layer or multiple layers.

The term "substrate" is meant herein any material, including a film, a non-woven fabric, a woven fabric, a foam or a combination thereof, or a dry lap material including wood pulp, and the like, having a single layer or multiple layers, and suitable for printing a polymeric material on at least one surface of the "substrate."

A "fibrous substrate" means herein a material comprised of a multiplicity of fibers that could be either a natural or synthetic material or any combination thereof. For example, nonwoven materials, woven materials, knitted materials, celluloid materials, and any combinations thereof.

The term "non-woven" refers herein to a fabric made from continuous filaments and/or discontinuous fibers, without weaving or knitting by processes such as spun-bonding and melt-blowing. The non-woven fabric can comprise one or more non-woven layers, wherein each layer can include continuous filaments or discontinuous fibers.

An "elastomer" refers herein to a polymer exhibiting elastic properties.

The term "elastic", "elastic properties" or "elasticized" refers herein to any material that upon application of a force to its relaxed, initial length can stretch or elongate to its elongated length without rupture and breakage, and which can substantially recover its initial length upon release of the applied force.

A "natural material" means herein a material derived from plants, animals, insects or byproducts of plants, animals, and insects. Non-limiting examples of natural materials useful in the disposable articles include celluloid fibers, cotton fibers, keratin fibers, silk fibers and the like. Non-limiting examples of celluloid fibers include wood pulp fibers, hemp fibers, jute fibers, and the like. Non-limiting examples of keratin fibers include wool fibers, camel hair fibers, and the like.

The term "stiffening region" refers herein to an area of a material having a greater modulus of elasticity than that of the adjacent areas of the material.

The term "elastic region" refers herein to an area of a material having a greater elastic properties than that of the adjacent areas of the material.

The term "breathable region" refers herein to an area of a material having a greater breathability (measured in grams per 24 hours of vapor transmission rate MVTR) than that of the adjacent areas of the material.

An article of the present invention can best be understood by reference to Figure 1 illustrating one embodiment of an absorbent article of the present invention, specifically a disposable diaper 10. For ease of understanding, much of the following description will be made in terms of the disposable diaper 10. The diaper 10 can comprise a multiplicity of impregnated thermoplastic members into nonwoven substrates of the diaper 10 providing specific material properties and/or specific functions for the diaper 10, such as, for example, a gasketing function around the legs of the wearer provided by an elastic region 11 of the article expressed by a leg elastic 12; another gasketing function around the waist of the wearer provided another elastic region 13 of the article expressed by the waist elastic 14 ; a fit function around the torso provided another elastic region 15 expressed by an elasticized side panel 16; a fastening function that provides closure for the diaper 10 is provided by a stiffening region 21 and a stiffening region 23, expressed as a slot member 20 and tab member 22, respectively, capable of engaging to effect a desired closure; and a breathable function for the diaper 10 provided by a breathable region 25 expressed by the outercover 24 providing transmission of vapors through the outercover as well as a barrier for liquids including waste exudates.

In order to provide the above functions for the product, the thermoplastic members impregnated into substrates result in new composite materials having a variety of unique properties contributed by the components of the new composite material which can provide desired physical properties at lower cost due to less polymeric materials than needed by conventional lamination technology. Because of the fibrous structure, the resulting composite materials have lighter weight and greater mechanical properties than the polymeric resin. The fibrous substrate provides desired structural fibrous network of generally interconnected fibers having desired tensile and stiffness properties. In addition, the percent fiber volume can affect the mechanical properties in the composite material.

Figure 2 illustrates a magnified plan view of one embodiment of an impregnated thermoplastic member 30 of the present invention forming a void 19 defined by the slot member 20 of the fastening system 18. The void 19 shown in Figure 2 is defined by a rectangular shape, however the void 19 can be defined by any suitable geometrical shape including a rectilinear outline, a curvilinear outline, a triangle, a trapezoid, a square, a parallelogram, a polygon, an ellipse, a circle, and any combination thereof. The impregnated thermoplastic member 30 provides the desired rigidity and strength around a slot opening 32. The size of the impregnated thermoplastic member 30 can vary in x-y-z directions, from millimeters to meters in x-y direction, and from microns to millimeters in the z direction. In one embodiment, the y dimension is 80 mm, the x dimension is 25 mm, and the z dimension can vary from about 0.3 mm to about 1.0 mm in a desired profile.

For example, in one embodiment of the present invention, the composite material of the slot and tab fastener system 18 comprises a polypropylene thermoplastic member fabricated from a polypropylene resin such as BASELL 917 manufactured by Basell Polyolefins Company N.V. of the Netherlands and a polyester nonwoven substrate such as manufactured by DuPont of Delaware under brand name SONTARA. The BASELL 917 polypropylene resin has a modulus of elasticity from about 150,000 psi to about 200,000 psi, and SONTARA polyester nonwoven have a modulus of elasticity from about 800,000 psi to about 1,300,000 psi. In one embodiment of the present invention, the resulting composite material comprising a fiber volume of about 10% to about 15% has a modulus of elasticity of about 250,000 psi to about 350,000 psi, which is significantly greater than the modulus of elasticity of the thermoplastic polypropylene resin.

Further, in regards to the tensile strength of the fastener system 18, BASELL 917 polypropylene resin has a tensile strength from about 30,000 psi to about 50,000 psi, and SONTARA polyester nonwoven substrate fibers have tensile strength from about 200,000 psi to about 300,000 psi. The resulting composite material comprising a fiber volume of about 10% to about 15% has a tensile strength of about 60,000 psi to about 150,000 psi, which is significantly greater than the tensile strength of the thermoplastic polypropylene resin.

The profile of the impregnated thermoplastic member 30 can be any suitable geometric contour having a linear or nonlinear profile. Figure 3 illustrates a cross sectional view of the impregnated thermoplastic member 30 shown in Figure 2, taken along cross lines 3-3. The thermoplastic member 30 is preferably at least partially impregnated into both substrates 34 and 36, which are combined together to form a new composite material 38. In one embodiment, the cross section of the member 30 can have a generally uniform thickness in the z-direction with tapering on the outer edges. Tapering is desired to provide flexibility at the edges to prevent discomfort to the wearer from stiff edges.

Similarly, Figure 4 illustrates a cross sectional view of the impregnated thermoplastic member 30 taken along cross lines 4-4, having a profiled thickness 31. The shape of the profiled thickness can be selected to provide a desired strength profile of the composite material 38, specifically, the shape of the profiled thickness varies to provide additional stiffness at the ends of the impregnated thermoplastic member 30 and more flexibility in the middle.

The outer cover 24 of the diaper 10 shown in Figure 1 includes a thermoplastic member 26 to provide desired breathability of the outer cover 24 while maintaining liquid impermeability of the outer cover 24. The thermoplastic member can be made from a variety of polymeric resins providing vapor permeability and liquid impermeability across the z direction. Examples of such materials can include monolithic polyesters like HYTREL manufactured by DuPont of Delaware, polyolefin materials that can include particulates like calcium carbonate, and others. The level of breathability and liquid impermeability can vary across the outer cover 24 by varying the thickness of the impregnated thermoplastic member 26 in the z direction.

In one embodiment of the present invention, the thermoplastic a member 26 can be manufactured from HYTREL that is at least partially impregnated into a High Elongation Carded polypropylene nonwoven manufactured by BBA Nonwovens Inc. of South Carolina, having a basis weight of about 22 grams/meter^2. The resulting composite material can provide breathability from about 2,000 GRAMS PER 24 HOURS MVTR to about 10,000 GRAMS PER 24 HOURS MVTR. The thickness of the thermoplastic member 26 can vary from about 10 microns to 35 microns, wherein higher degree of breathability can be provided in areas of lower thickness and a greater liquid impermeability can be provided in areas of greater thickness. For example, in the crotch area of diaper 10 where greater liquid impermeability is desired, the thickness of the thermoplastic member 26 can be greater than in other areas of the outer cover 24.

The waist elastic 14 of the diaper 10 shown in Figure 1 includes a thermoplastic member 28 to provide desired elasticity of the waist 14 providing desired comfort, gasketing, and sustained fit. The elastic property of the waist elastic 14 can be provided by a variety of thermoplastic elastomeric resins providing elastic properties across the thermoplastic member. In one embodiment of the present invention the thermoplastic member 28 can be manufactured from KRATON styrenic block copolymer, available from Shell Corporation, that is at least partially impregnated into a High Elongation Carded polypropylene nonwoven manufactured by BBA Nonwovens Inc. of South Carolina having a basis weight of about 22 grams/meter^2. The resulting composite material can provide elastic force at 200% elongation from about 400 grams/inch to about 1000 grams/inch. The width 46 of the thermoplastic member 28 perpendicular to the direction of stretch forces can vary from about 2mm to about 200mm and the thickness of the thermoplastic member 28 can vary from about 30 microns to 150 microns, wherein a greater degree of elastic force can be provided in areas of greater width and/or thickness. For example, in the back waist area 40 of the diaper 10 where a greater elastic force can be desired, the thickness and/or width of the thermoplastic member 28 can be greater than in other areas of the waist 14.

The leg elastic 12 of the diaper 10 shown in Figure 1 includes a thermoplastic member 42 to provide desired elasticity of the leg elastic 12 providing desired comfort and gasketing. The elastic property of the leg elastic 12 can be provided by a variety of thermoplastic elastomeric resins providing elastic properties across the thermoplastic member. In one embodiment of the present invention, the thermoplastic member 42 can be manufactured from KRATON styrenic block copolymer available from Shell Corporation, that is at least partially impregnated into a High Elongation Carded polypropylene nonwoven manufactured by BBA Nonowovens Inc. of South Carolina, having a basis weight of about 22 grams/meter^2. The resulting composite material can provide elastic force at 200% elongation from about

50 grams/inch to about 100 grams/inch. The width of the thermoplastic member 42 perpendicular to the direction of stretch forces can vary from about 2mm to about 20mm and the thickness of the thermoplastic member 42 can vary from about 30 microns to 150 microns, wherein a greater degree of elastic force can be provided in areas of greater width and/or thickness. For example, in the back leg area 44 of the diaper 10 where a greater elastic force can be desired, the thickness and/or width of the thermoplastic member 42 can be greater than in other areas of the leg elastic 12.

The elastic side panel 16 of the diaper 10 shown in Figure 1 includes thermoplastic member 48 to provide desired elasticity of the elastic side panel 16 providing desired comfort and sustained fit. The elastic property of the elastic side panel 16 can be provided by a variety of thermoplastic elastomeric resins providing elastic properties across the thermoplastic member. In one embodiment of the present invention the thermoplastic member 48 can be manufactured from KRATON styrenic block copolymer available from Shell Corporation, that is at least partially impregnated into a High Elongation Carded polypropylene nonwoven manufactured by BBA Nonwovens Inc. of South Carolina, having a basis weight of about 22 grams/meter^2. The resulting composite material can provide elastic force at 200% elongation from about 100 grams/inch to about 500 grams/inch. The width of the thermoplastic member 48 perpendicular to the direction of stretch forces can vary from about 2mm to about 200mm and the thickness of the thermoplastic member 48 can vary from about 30 microns to 150 microns, wherein a greater degree of elastic force can be provided in areas of greater width and/or thickness. For example, in the waist direction of the elastic side panel 16 of the diaper 10 where a greater elastic force can be desired, the thickness and/or width of the thermoplastic member 48 can be greater than in the leg direction of elastic side panel 16.

The above composite materials can be manufactured by a process 50 of the present invention, one embodiment of which is illustrated schematically in Figure 5. The process 50 is capable of at least partially impregnating thermoplastic members into one or more fibrous substrates by one embodiment of a process 50. The thermoplastic members can be impregnated into the fibrous substrate through a variety of means suitable for supplying and depositing molten thermoplastic resins. The means could include ink jet, spraying, coating, screen-printing, intaglio printing, flexographic printing, and the like. In the preferred embodiment of the present invention, the means of supplying and depositing molten thermoplastic resins can be provided by a rotogravure printing process because it provides flexibility in desired x-y-z dimensions of the thermoplastic member and desired quantity of deposition of the molten thermoplastic resin.

Figure 5 shows a fibrous substrate 36, which can be provided by a supply roll 52, moving through a rotogravure printing device 54 that deposits molten thermoplastic members 60 onto the fibrous substrate 36 to at least partially impregnate the fibrous substrate 36. Then, if desired, a fibrous substrate 34, which can be provided by a supply roll 56, can be combined with the substrate 36 to cover the molten thermoplastic member 60 and allow the molten member 60 to at least partially impregnate into the substrate 34 to form a composite material 38.

The degree of impregnation of both substrates 34, 36 by the molten thermoplastic member 60 can be controlled by applying a desired pressure onto the composite material 38 to affect the impregnation. As described above, the substrates 34 and 36 can be any suitable fibrous substrate in any suitable combination. (Alternatively, composite materials of the present invention can include materials, wherein at least one substrate is fibrous. Nonfibrous substrates can include films, foils, foams, and the like.) The source of the pressure can be any suitable means, including contacting or noncontacting means. Figure 5 shows an example of a contacting means provided by a nip roll pair 58 which can be heated or chilled. Further, the degree of impregnation can be affected by the viscosity of the molten thermoplastic member 60, the porosity of the fibrous substrates 34 and 36, and the surface tension of both the molten thermoplastic member 60 and the fibrous substrate. The rotogravure-printing device 54 can be any suitable conventional thermal rotogravure device. One suitable rotogravure-printing device can be obtained from Roto-Therm Inc. of California.

Figure 6 illustrates a magnified view of a rotogravure pattern 70 for depositing the molten thermoplastic member 60. As shown, the cells 72 are preferably intersecting with each other to provide a contiguous distribution of the molten thermoplastic member 60 along the rotogravure pattern 70, which result in a contiguous distribution of the molten thermoplastic resin in the thermoplastic member 60.

For example, the composite material of the slot and tab fastening system 18 can be manufactured by the above process utilizing two substrates 34 and 36, molten thermoplastic member 60, and subsequent compression of the composite material 38. The composite material of the breathable outer cover 24 can be manufactured by the above process utilizing preferably a single fibrous substrate 36. The composite material of the elastic waist 14 and leg elastic 12 can be manufactured by the above process utilizing either one or more fibrous substrates. The composite material of the elastic side panel 16 can be manufactured by the above process using one or more fibrous substrates.

The elastic properties of the leg elastic 12, the waist elastic 14, and the side panel elastic 16 can be provided by various secondary operations, including incremental stretching of the composite material to permanently elongate the fibrous substrate to enable the thermoplastic member to stretch within the provided elongation of the substrate. Alternatively, prior to depositing the molten thermoplastic member, the fibrous substrates can be strained to consolidate the fibrous substrate in the cross direction, which after deposition of the molten thermoplastic member, can expand under a force in the cross direction to enable the thermoplastic member to stretch within the provided expansion of the substrate.

Alternatively, other process embodiments of the present invention can include the use of multiple deposition devices to provide multiple depositions of thermoplastic materials onto one or more substrates, including deposition onto two substrates separately and then combing them, and/or making several subsequent depositions onto the same substrate. Further, the use of multiple deposition devices can provide a greater deposition weight of the molten thermoplastic material, a greater z dimension profile variation, capability to deposit different thermoplastic materials, and capability to deposit thermoplastic materials of different colors, and any combinations thereof.

While particular embodiments and/or individual features 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. Further, it should be apparent that all combinations of such embodiments and features are possible and can result in preferred executions of the invention. Therefore, the appended claims are intended to cover all such changes and modifications that are within the scope of this invention.

WHAT IS CLAIMED IS:

1. An article comprising one or more shaped thermoplastic members at least partially impregnated into one or more fibrous substrates forming a composite material, wherein the shaped thermoplastic members have a profiled thickness providing variation in material properties, and wherein a percent variation of the profiled thickness of the thermoplastic member can vary from about 5% to about 100%.

2. The article of Claim 1, wherein the percent variation varies from about 20% to about 80%.

3. The article of Claim 1, wherein the composite material forms a stiffening region of the article having a modulus of elasticity from about 800,000 psi to about 3,500,000 psi.

4. The article of Claim 1, wherein the composite material forms a slot and tab fastening system having a modulus of elasticity from about 800,000 psi to about 3,500,000 psi.

5. The article of Claim 1, wherein the composite material forms a breathable region of the article having a vapor transmission rate of about 2,000 grams per 24 hours MVTR to about 10,000 grams per 24 hours MVTR.

6. The article of Claim 1, wherein the composite material forms a breathable region of the article having a hydrostatic head pressure from about 18 inches of water to about 30 inches of water.

7. The absorbent article of Claim 1, wherein the composite material forms a breathable region of the article having a dynamic liquid impact from about 0 grams to about 5 grams.

8. The article of Claim 1, wherein the composite material forms an elastic region of the article having an elastic force at 200% elongation from about 50 grams/inch to about 1,000 grams/inch.

9. The article of Claim 1, wherein the composite material forms a leg elastic region of the article having an elastic force at 200% elongation from about 50 grams/inch to about 100 grams/inch.

10. The article of Claim 1, wherein the composite material forms a waist elastic having an elastic force at 200% elongation from about 400 grams/inch to about 1,000 grams/inch.

11. The article of Claim 1, wherein the composite material forms an elastic side panel having an elastic force at 200% elongation from about 100 grams/inch to about 500 grams/inch.

12. The article of Claim 1, wherein the shaped thermoplastic member has a shape selected from the group consisting of an area having a rectilinear outline, a curvilinear outline, a triangle, a square, a trapezoid, a parallelogram, a polygon, a circle, an ellipse, and any combination thereof.

13. The article of Claim 1, wherein the shaped thermoplastic member has at least one void defined by a shape selected from the group consisting of an area having a rectilinear outline, a curvilinear outline, a triangle, a square, a trapezoid, a parallelogram, a polygon, a circle, an ellipse, and any combination thereof.

14. The article of Claim 1, wherein the shaped thermoplastic member comprises a material selected from the group consisting of a thermoplastic polymer, a thermoplastic elastomer, a superabsorbent polymer, a polyolefin, a polyester, a polyamide, a polyurethane, a hot melt adhesive, and any mixture or combination thereof.

15. The article of Claim 1, wherein the fibrous substrate is selected from the group consisting of a polymeric material, a natural material, a woven fabric, a non-woven fabric, a knit fabric, cellulose material, and any combination thereof.

16. The article of Claim 1, wherein the article is selected from the group consisting of baby diapers, adult incontinence articles, feminine hygiene articles, baby swim diapers, dining bibs, wound dressings, sports wear, undergarments, outer wear, rain coats, hospital garments, and cleansing wipes.

17. An article comprising one or more shaped thermoplastic members at least partially impregnated into one or more fibrous substrates forming a composite material, wherein the shaped thermoplastic members have a profiled basis weight providing variation in material properties, and wherein a percent variation of the profiled basis weight of the thermoplastic member can vary from about 5% to about 100%.

18. A method of making a composite material comprising at least one shaped thermoplastic member impregnated into at least one fibrous substrate, the method comprising the steps of:

e) providing a first fibrous substrate;

f) depositing a first thermoplastic material on the first fibrous substrate to form at least one shaped thermoplastic member having a profiled thickness providing variation in material properties, wherein a percent variation of the profiled thickness of the thermoplastic member can vary from about 5% to about 100%, and wherein the step of depositing is selected from a group consisting of gravure printing, screen printing, ink jet printing, and flexographic printing;

g) providing a second substrate; and

h) combining the first substrate and the second substrate to form the composite material, wherein the thermoplastic member is at least partially impregnated into the first substrate.

19. The method of Claim 18, wherein the thermoplastic material is at least partially impregnated into the second substrate.

20. The method of Claim 18, wherein the second substrate is not fibrous.

21. The method of Claim 18, wherein the second substrate is fibrous.

22. The method of Claim 20 further comprising a step of depositing a second thermoplastic material on the second fibrous substrate to form a second shaped thermoplastic member, wherein the step of depositing is selected from a group consisting of gravure printing, screen-printing, ink jet printing, and flexographic printing.

23. The method of Claim 21, wherein the first thermoplastic member and the second thermoplastic member are different materials.

24. The method of Claim 18 further comprising a step of depositing a second thermoplastic material on the first fibrous substrate on top of the first shaped thermoplastic member, wherein the step of depositing is selected from a group consisting of gravure printing, screen-printing, ink jet printing, and flexographic printing.

25. The method of Claim 24, wherein the first shaped thermoplastic member and the second shaped thermoplastic member are different materials.

26. The method of Claim 24, wherein the first shaped thermoplastic member and the second shaped thermoplastic member are same materials.

ARTICLES COMPRISING IMPREGNATED THERMOPLASTIC MEMBERS AND METHOD OF MANUFACTURING THE ARTICLES

ABSTRACT OF THE DISCLOSURE

An article, including disposable articles and durable articles, includes one or more shaped thermoplastic members, which can be at least partially impregnated into one or more fibrous substrates forming a composite material of the article having regions of breathability, elasticity, and/or stiffening to provide desired functions of the article. The shaped thermoplastic members have a profiled thickness and/or basis weight providing variation in material properties. A percent variation of the profiled thickness of the thermoplastic member can vary from about 5% to about 100%. A process for manufacturing the article is also disclosed.

Figure 1

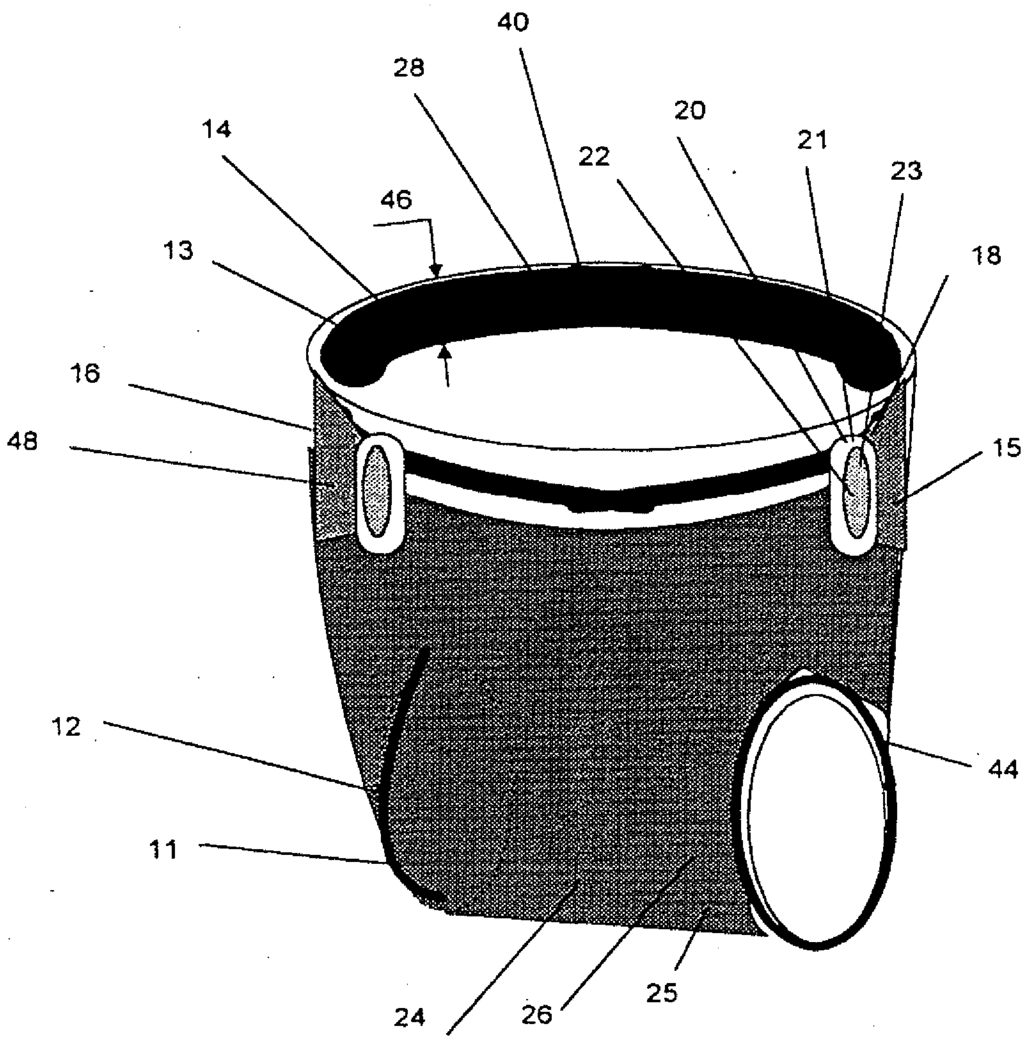


Figure 2

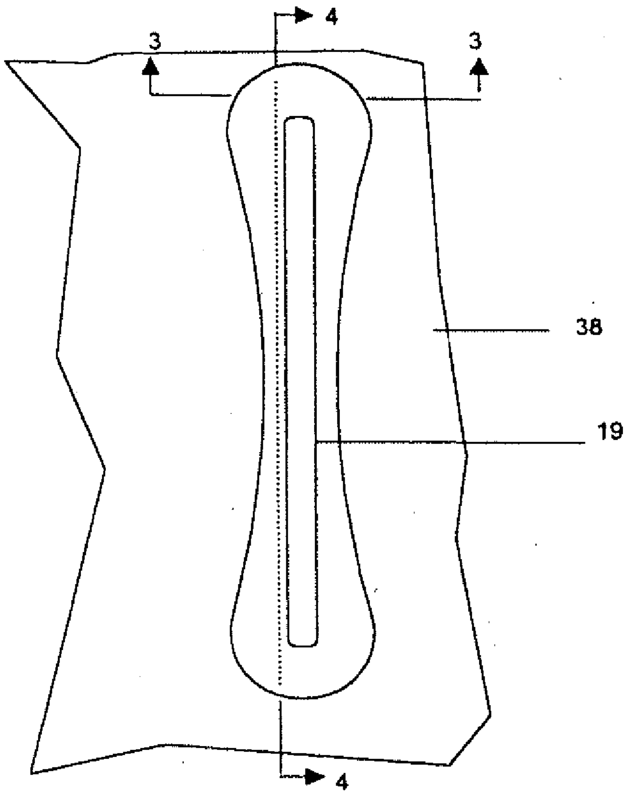
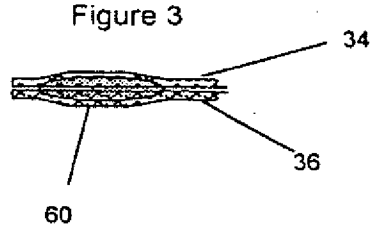


Figure 3



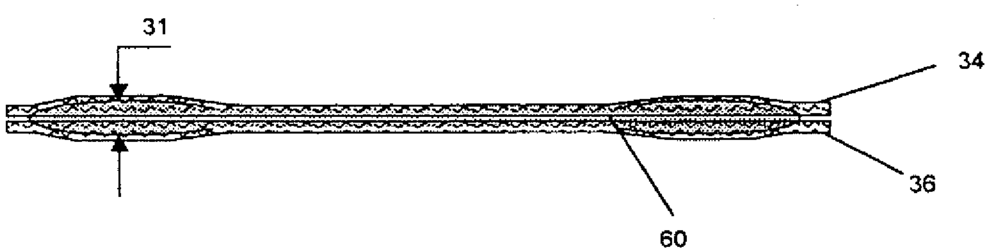
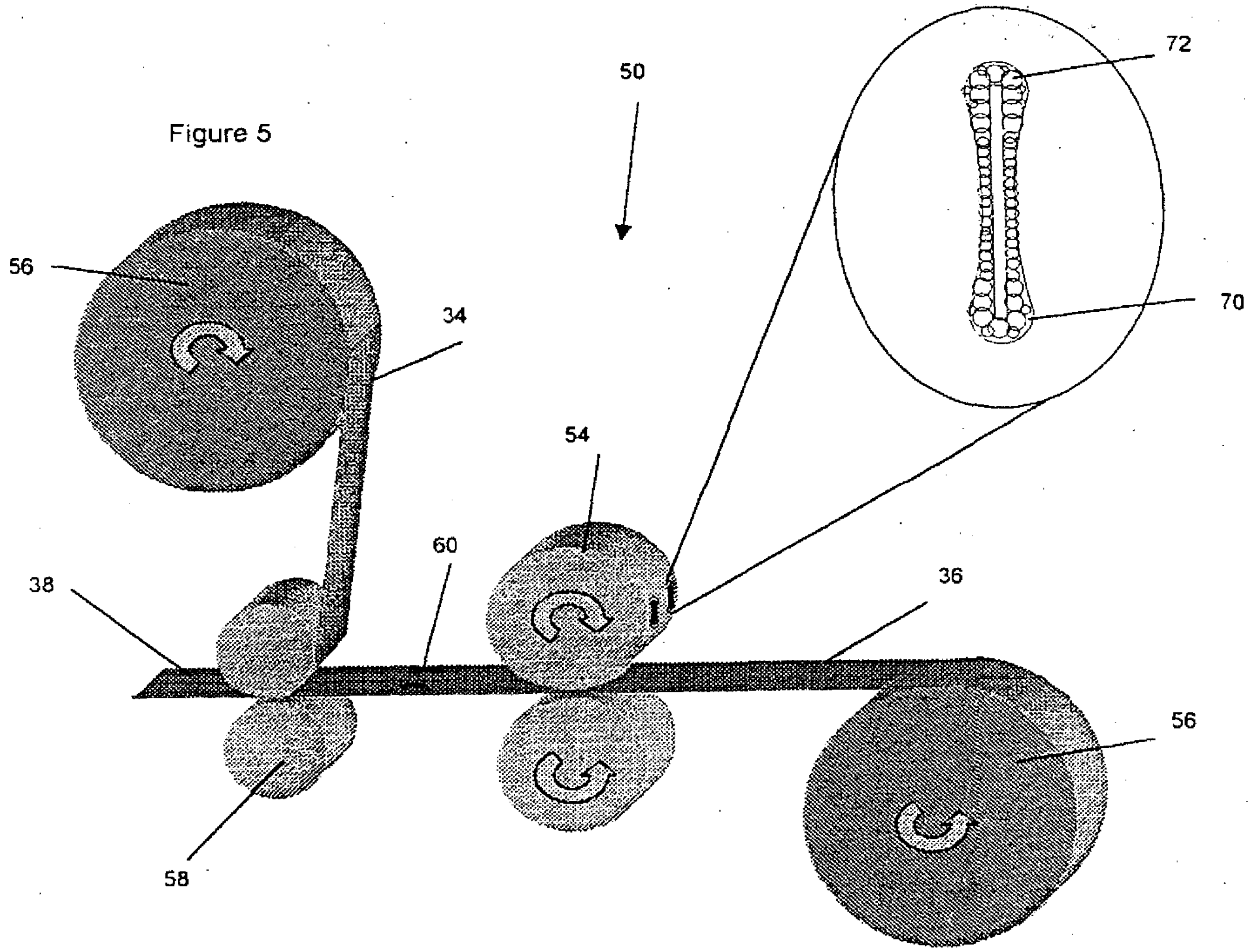


Figure 4

Figure 6

Figure 5



UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
10/012,894	11/05/2001	1772	0.00	56502US002	10	42	3

CONFIRMATION NO. 1330

26813
MUETING, RAASCH & GEBHARDT, P.A.
P.O. BOX 581415
MINNEAPOLIS, MN 55458

FILING RECEIPT

OC000000007354786

Date Mailed: 01/24/2002

Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Customer Service Center. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).**

Applicant(s)

Domestic Priority data as claimed by applicant

Foreign Applications

If Required, Foreign Filing License Granted 01/24/2002

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Title

Systems and methods for composite webs with structured discrete polymeric regions

Preliminary Class

428

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184

SYSTEMS AND METHODS FOR COMPOSITE WEBS WITH STRUCTURED DISCRETE POLYMERIC REGIONS

FIELD OF THE INVENTION

The present invention relates to systems and methods for manufacturing composite webs that include structured discrete polymeric regions on at least one surface thereof.

BACKGROUND

The manufacture of articles that include thermoplastic structures useful to, e.g., fasten articles together (hook and loop systems, capped stems, etc.) are known. Such processes, however, typically provide thermoplastic structures that are located over an entire substrate or web. Where smaller, discrete regions of fastening or other structures are required, pieces of the pre-formed thermoplastic structures are often attached to a separate article, e.g., the fastening tab of a diaper or incontinence garment.

The handling and attachment of such discrete pieces can, however, be problematic, by potentially reducing throughput, causing waste (where the discrete pieces are not securely attached), etc. The discrete pieces may also present relatively sharp edges that may be the source of irritation or discomfort.

Some of these issues are addressed in U.S. Patent Application Serial No. 09/257,447 by Tuman et al., filed on February 25, 1999, titled WEB HAVING DISCRETE STEM REGIONS (also published as International Publication No. WO 00/50229). That document describes webs having discrete polymeric regions formed thereon by the use of extrusion coating (with or without the use of rotating blades). The extrusion coating may be performed using a series of nozzles that may be cycled to deliver discrete amounts of polymeric material to a web. Another alternative method discussed in the document is the use of screen printing.

All of the methods for forming discrete polymeric regions disclosed by WO 00/50229 include some disadvantages. For example, the use of extrusion dies and/or nozzles and any associated equipment (e.g., rotating blades, etc.) may result in limited shapes that can be formed on the webs. Another potential disadvantage is that the speed at which the patterns may be formed is somewhat limited, especially where larger or thicker discrete polymeric regions are required. Another disadvantage associated with extrusion-based systems is that the ability to form some shapes with any precision may be limited by the nature of the extrusion process.

As for the use of screen printing to form discrete polymeric regions, one disadvantage is that the amount of material that can be delivered through the orifices of a screen may not be sufficient to allow for forming of structures after deposition of the discrete polymeric regions, particularly when the thermoplastic compositions used for the discrete polymeric regions have a relatively high viscosity. More importantly, however, may be the limitations on screen orifice size. If the orifices are too large, the integrity of the screen can be impaired, particularly if higher pressures are required to force higher viscosity materials through the screen orifices.

Another disadvantage related to screen orifices is that orifices that extend continuously about the circumference of the screen printing roll cannot be provided without destroying the integrity of the roll. Further, orifices that extend too far in any direction can significantly limit the forces that can be applied to the screen printing roll without excessive distortion of the screen printing roll.

Another disadvantage of screen printing processes is that the ability to force the molten thermoplastic composition into the substrate (where, e.g., the substrate is porous, fibrous, etc.) may be limited because no physical structure is provided directly opposite from the substrate on which the discrete polymeric regions are deposited.

Screen integrity may also limit the amount of pressure that can be applied to clean the screen of the molten thermoplastic composition between printing passes. As the thermoplastic material builds up on the screen, it may be subject to charring or other degradation that could further hamper performance of the system as a whole.

SUMMARY OF THE INVENTION

The present invention provides systems and methods for manufacturing composite webs including a substrate with one or more discrete polymeric regions located thereon. Each of the discrete polymeric regions is further formed to include multiple structures formed thereon. Those structures may include, for example, stems (capped or otherwise), hooks (as part of a hook and loop fastening system), pyramids, etc.

One advantage of the systems and methods of the present invention is the ability to transfer one or more discrete polymeric regions onto a major surface of a substrate, where the thermoplastic material of the discrete polymeric region can be forced against the substrate by a transfer roll. If the substrate is porous, fibrous, etc., pressure may enhance attachment of the discrete polymeric regions to the substrates by forcing a portion of the thermoplastic composition to infiltrate the substrate and/or encapsulate fibers of the substrate.

Another advantage of the systems and methods of the present invention is the ability to produce a composite web including discrete structured polymeric regions formed thereon in a single pass, with the input of a substrate and molten thermoplastic composition.

Another advantage is the ability to control the shape, spacing, and volume of the discrete polymeric regions. This may be particularly advantageous because these parameters (shape, spacing, and volume) can be fixed regardless of the line speed of the system.

Another advantage of the systems and methods of the present invention is the ability to provide one or more discrete polymeric regions that extend for the length of the substrate (while not being formed over the width of the substrate, i.e., the discrete polymeric regions are not coextensive with the major surface of the substrate). The use a transfer roll to form such continuous discrete polymeric regions may advantageously provide substantial control over the shape and size of the polymeric regions.

Another advantage of the systems and methods of the present invention is the ability to provide different thermoplastic compositions across the width of the substrate, such that some discrete polymeric regions may be formed of one thermoplastic composition, while other discrete polymeric regions are formed of a different thermoplastic composition.

Still another advantage of the systems and methods of the present invention is that the types of features formed in different discrete polymeric regions on the substrate may vary both across the width of the composite web, as well as in the down-web direction.

Yet another advantage of the systems and methods of the present invention is the ability to provide one or more discrete polymeric regions on both major surfaces of a substrate. The discrete polymeric regions on the opposing major surfaces may be formed with the same or different features as desired.

In one aspect, the present invention provides a method for producing a composite web by providing a transfer roll including an exterior surface with one or more depressions formed therein and delivering a molten thermoplastic composition onto the exterior surface of the transfer roll. The molten thermoplastic composition is wiped from the exterior surface of the transfer roll, wherein a portion of the molten thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten thermoplastic composition from the exterior surface of the transfer roll. At least a portion of the molten thermoplastic composition in the one or more depressions is transferred to a first major surface of a substrate by contacting the first surface of the substrate to the exterior surface of the transfer roll and the molten thermoplastic composition in the one or more depressions, followed by separating the substrate from the transfer roll, wherein one or more discrete polymeric regions formed from the thermoplastic composition are located on the first major surface of the substrate after separating the substrate from the transfer roll. The one or more discrete polymeric regions on the substrate are placed in contact with a forming tool under pressure, wherein a portion of the thermoplastic composition in at least one discrete polymeric region of the one or more discrete polymeric regions contacting the forming tool enters a plurality of cavities in the forming tool. The method further includes separating the substrate and the one or more discrete polymeric regions from the forming tool, wherein the at least one discrete polymeric region includes a plurality of structures formed thereon after separating the one or more discrete polymeric regions from the forming tool, the plurality of structures corresponding to the plurality of cavities in the forming tool.

In another aspect, the present invention provides a method for producing a composite web by providing a transfer roll including an exterior surface with one or more depressions formed therein and delivering a molten thermoplastic composition onto the exterior surface of the transfer roll. The molten thermoplastic composition is wiped from the exterior surface of the transfer roll, wherein a portion of the molten thermoplastic composition enters the one or more depressions, and wherein the portion of the molten thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten thermoplastic composition from the exterior surface of the transfer roll, and substantially all of the one or more depressions are substantially filled with the molten thermoplastic composition after the wiping. The method further includes forcing a portion of a first major surface of a substrate into the one or more depressions, wherein the first major surface has a porous surface including fibers, and wherein a portion of the molten thermoplastic composition in the one or more depressions infiltrates the porous surface, and still further wherein the molten thermoplastic composition encapsulates at least a portion of at least some of the fibers. The substrate is separated from the transfer roll, wherein one or more discrete polymeric regions formed of the thermoplastic composition are located on the first major surface of the substrate after separating the substrate from the transfer roll. The one or more discrete polymeric regions on the substrate are placed in contact with a forming tool under pressure, wherein a portion of the thermoplastic composition in at least one discrete polymeric region of the one or more discrete polymeric regions contacting the forming tool enters a plurality of cavities in the forming tool. The substrate and the one or more discrete polymeric regions are separated from the forming tool, wherein the at least one discrete polymeric region includes a plurality of structures formed thereon after separating the one or more discrete polymeric regions from the forming tool, the plurality of structures corresponding to the plurality of cavities in the forming tool.

In another aspect, the present invention provides a system for manufacturing composite webs. The system includes a web path defining a downstream direction along which a substrate moves through the system. The system also includes a molten thermoplastic composition delivery apparatus and a transfer roll. The transfer roll is located along the web path and includes an exterior surface and one or more depressions formed in the exterior surface of the transfer roll, wherein a portion of the exterior surface of the transfer roll is in contact with a first major surface of a substrate located on the web path. The transfer roll is positioned to receive molten thermoplastic composition from the molten thermoplastic delivery apparatus such that molten thermoplastic composition enters the one or more depressions. A wiping apparatus is in contact with the exterior surface of the transfer roll, the wiping apparatus positioned to remove molten thermoplastic composition from the exterior surface of the transfer roll before the molten thermoplastic composition on the exterior surface of the transfer roll contacts the substrate. A transfer nip is located along the web path, wherein the first major surface of the substrate is forced against the exterior surface of the transfer roll at the transfer nip, whereby at least a portion of the molten thermoplastic composition in the one or more depressions transfers to the first major surface of the substrate during operation of the system to form one or more discrete polymeric regions on the first major surface of the substrate. The system also includes a forming nip located along the web path downstream from the transfer nip, wherein a forming tool is forced against the first major surface of the substrate and the one or more discrete polymeric regions in the forming nip, the forming tool including a plurality of cavities facing the first major surface of the substrate, the plurality of cavities forming a plurality of structures on the one or more discrete polymeric regions.

These and other features and advantages of methods according to the present invention are described below in connection with various illustrative embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of one composite web manufactured according to the methods of the present invention.

FIG. 2 is a cross-sectional view of another composite web manufactured according to the methods of the present invention.

FIG. 3 is a plan view of a composite web manufactured according to the methods of the present invention.

FIG. 4 is a cross-sectional view of a composite web manufactured according to the methods of the present invention including capped stems.

FIG. 5 is a cross-sectional view of a composite web manufactured according to the methods of the present invention including hooks.

FIG. 6 is a cross-sectional view of a composite web manufactured according to the methods of the present invention including formed structures.

FIG. 7 is a cross-sectional view of a composite web manufactured according to the methods of the present invention including discrete polymeric regions on both major surfaces of a substrate.

FIG. 8 is a perspective view of one polymer transfer process useful in providing discrete polymeric regions on a substrate in accordance with the methods of the present invention.

FIG. 8A is an enlarged partial cross-sectional view depicting wiping of the transfer roll by a doctor blade.

FIG. 8B is an enlarged partial cross-sectional view depicting a conformable backup roll forcing a substrate against a transfer roll.

FIG. 8C is an enlarged partial cross-sectional view depicting a mating backup roll including protrusions aligned with depressions in the transfer roll.

FIG. 8D is a schematic diagram of an alternative system for manufacturing composite webs in accordance with the present invention.

FIG. 9 illustrates another transfer roll and polymer source useful in connection with zoned delivery systems and methods.

FIG. 10 is a plan view of one depression on a transfer roll that may be used in connection with the methods of the present invention.

FIG. 11 is a cross-sectional view of the depression of FIG. 10 taken along line 11-11 in FIG. 10.

FIG. 12 is a plan view of alternative depressions on a transfer roll that may be used in connection with the methods of the present invention.

FIG. 13 is a cross-sectional view of one depression of FIG. 12 taken along line 13-13 in FIG. 12.

FIG. 14 is a plan view of a portion of one composite web manufactured according to the present invention.

FIG. 15 is a perspective view of one transfer roll that may be used to manufacture the composite web of FIG. 14.

FIG. 16 is a plan view of a portion of one composite web manufactured according to the present invention that includes discrete polymeric regions extending across the width of the substrate.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS OF THE INVENTION

As discussed above, the present invention provides methods and systems for producing composite webs that include a substrate with discrete polymeric regions located thereon. Various different constructions will now be described to illustrate various embodiments of the composite webs that can be manufactured using the systems and methods of the present invention. These illustrative constructions should not be considered to limit the present invention, which is to be limited only by the claims that follow.

FIG. 1 is a cross-sectional view of a portion of one composite web manufactured in accordance with the present invention. The composite web includes a substrate 10 with a first major surface 18 and a second major surface 19. A plurality of discrete polymeric regions 14 are located on the first major surface 18 of the substrate 10.

The discrete polymeric regions 14 of composite webs manufactured in accordance with the present invention each include some structure protruding from a base 13. In the embodiment depicted in FIG. 1, the structure is in the form of a plurality of stems 12. The depicted stems 12 are oriented substantially perpendicular to the base 13 of the discrete polymeric regions 14, as well as the underlying substrate 10. Although the stems 12 each include rounded tips, it will be understood that the exact form and structure of the stems 12 may vary based on the intended use of the composite web.

Furthermore, although all of the stems 12 are shown as having the same shape, it will be understood that a variety of differently sized and/or shaped stems may be provided as desired based on the intended use of the composite web.

The different discrete polymeric regions 14 are separated by exposed areas 16 on the first major surface 18 of substrate 10. As depicted in FIG. 1, the spacing, i.e., the size of the exposed area 16 between the discrete polymeric regions 14 may be the same or different. For example, the exposed area 16 located between the left-most pair of discrete polymeric regions 14 is larger than the exposed area 16 located between the right-most pair of discrete polymeric regions 14.

The discrete polymeric regions 14 may cover any desired portion of the surface area of the substrate 10 on which they are positioned, although it will be understood that the discrete polymeric regions 14 will not cover all of the surface of the substrate 10. Some variations in the percentage of surface area occupied by discrete polymeric regions may be as described in, for example, pending U.S. Patent Application Serial No. 09/257,447, entitled WEB HAVING DISCRETE STEM REGIONS, filed on Feb. 25, 1999 (published as International Publication No. WO 00/50229).

Further, although the discrete polymeric regions 14 are depicted as being disconnected from each other, it should be understood that some composite webs manufactured with the systems and methods of the present invention may include a relatively thin skin layer of the thermoplastic composition used to form the discrete polymeric regions. Such a skin layer may, in some instances, connect some or all of the discrete polymeric regions on the composite web. In any event, however, the amount of polymeric material in the skin layer will be insufficient to allow for the formation of structures (e.g., stems, hooks, pyramids, etc.) outside of the discrete polymeric regions.

The substrates used in connection with the composite webs of the present invention may have a variety of constructions. For example, the substrates may be a woven material, nonwoven material, knit material, paper, film, or any other continuous media that can be fed through a nip point. The substrates may have a wide variety of properties, such as extensibility, elasticity, flexibility, conformability, breathability, porosity, stiffness, etc. Further, the substrates may include pleats, corrugations or other deformations from a flat planar sheet configuration.

In some instances, the substrates may exhibit some level of extensibility and also, in some instances, elasticity. Extensible webs that may be preferred may have an initial yield tensile force of at least about 50 gm/cm, preferably at least about 100 gm/cm. Further, the extensible webs may preferably be extensible nonwoven webs.

Suitable processes for making a nonwoven web that may be used in connection with the present invention include, but are not limited to, airlaying, spunbond, spunlace, bonded melt blown webs and bonded carded web formation processes. Spunbond nonwoven webs are made by extruding a molten thermoplastic, as filaments from a series of fine die orifices in a spinneret. The diameter of the extruded filaments is rapidly reduced under tension by, for example, by non-eductive or eductive fluid-drawing or other known spunbond mechanisms, such as described in U.S. Patent Nos. 4, 340,563 (Appel et al.); 3,692,618 (Dorschner et al.); 3,338,992 and 3,341,394 (Kinney); 3,276,944 (Levy); 3,502,538 (Peterson); 3,502,763 (Hartman) and 3,542,615 (Dobo et al.). The spunbond web is preferably bonded (point or continuous bonding).

The nonwoven web layer may also be made from bonded carded webs. Carded webs are made from separated staple fibers, which fibers are sent through a combing or carding unit which separates and aligns the staple fibers in the machine direction so as to form a generally machine direction-oriented fibrous nonwoven web. However, randomizers can be used to reduce this machine direction orientation.

Once the carded web has been formed, it is then bonded by one or more of several bonding methods to give it suitable tensile properties. One bonding method is powder bonding wherein a powdered adhesive is distributed through the web and then activated, usually by heating the web and adhesive with hot air. Another bonding method is pattern bonding wherein heated calender rolls or ultrasonic bonding equipment are used to bond the fibers together, usually in a localized bond pattern though the web can be bonded across its entire surface if so desired. Generally, the more the fibers of a web are bonded together, the greater the nonwoven web tensile properties.

Airlaying is another process by which fibrous nonwoven webs useful in the present invention can be made. In the airlaying process, bundles of small fibers usually having lengths ranging between about 6 to about 19 millimeters are separated and entrained in an air supply and then deposited onto a forming screen, often with the assistance of a vacuum supply. The randomly deposited fibers are then bonded to one another using, for example, hot air or a spray adhesive.

Meltblown nonwoven webs may be formed by extrusion of thermoplastic polymers from multiple die orifices, which polymer melt streams are immediately attenuated by hot high velocity air or steam along two faces of the die immediately at the location where the polymer exits from the die orifices. The resulting fibers are entangled into a coherent web in the resulting turbulent airstream prior to collection on a collecting surface. Generally, to provide sufficient integrity and strength for the present invention, meltblown webs must be further bonded such as by through air bonding, heat or ultrasonic bonding as described above.

A web can be made extensible by skip slitting as is disclosed in, e.g., International Publication No. WO 96/10481 (Abuto et al.). If an elastic, extensible web is desired, the slits are discontinuous and are generally cut on the web prior to the web being attached to any elastic component. Although more difficult, it is also possible to create slits in the nonelastic web layer after the nonelastic web is laminated to the elastic web. At least a portion of the slits in the nonelastic web should be generally perpendicular (or have a substantial perpendicular vector) to the intended direction of extensibility or elasticity (the at least first direction) of the elastic web layer. By generally perpendicular it is meant that the angle between the longitudinal axis of the chosen slit or slits and the direction of extensibility is between 60 and 120 degrees. A sufficient number of the described slits are generally perpendicular such that the overall laminate is elastic. The provision of slits in two directions is advantageous when the elastic laminate is intended to be elastic in at least two different directions.

A nonwoven web used in connection with the present invention can also be a necked or reversibly necked nonwoven web as described in U.S. Patent Nos. 4,965,122; 4,981,747; 5,114,781; 5,116,662; and 5,226,992 (all to Morman). In these embodiments the nonwoven web is elongated in a direction perpendicular to the desired direction of extensibility. When the nonwoven web is set in this elongated condition, it will have stretch and recovery properties in the direction of extensibility.

The substrates used in connection with the present invention may preferably exhibit some porosity on one or both of the major surfaces of the substrate such that when a molten thermoplastic composition is provided on one of the major surfaces of the substrate, a mechanical bond is formed between the molten thermoplastic composition and the substrate as the molten thermoplastic composition infiltrates and/or encapsulates a portion of the porous surface of the substrate. As used in connection with the present invention, the term "porous" includes both structures that include voids formed therein, as well as structures formed of a collection of fibers (e.g., woven, nonwoven, knit, etc.) that allow for the infiltration of molten thermoplastic composition into the interstices between fibers. If the porous surface includes fibers, the thermoplastic composition may preferably encapsulate fibers or portions of fibers on the surface of the substrate.

The type and construction of the material or materials in the substrate should be considered when selecting an appropriate substrate to which a molten thermoplastic composition is applied. Generally, such materials are of the type and construction that do not melt, soften, or otherwise disintegrate under the temperatures and pressures experienced during the step of transferring the thermoplastic composition to the substrate. For example, the substrate should have sufficient internal strength such that it does not fall apart during the process. Preferably, the substrate has sufficient strength in the machine direction at the temperature of the transfer roll to remove it intact from the transfer roll.

As used herein, the term "fiber" includes fibers of indefinite length (e.g., filaments) and fibers of discrete length, e.g., staple fibers. The fibers used in connection with the present invention may be multicomponent fibers. The term "multicomponent fiber" refers to a fiber having at least two distinct longitudinally coextensive structured polymer domains in the fiber cross-section, as opposed to blends where the domains tend to be dispersed, random, or unstructured. The distinct domains may thus be formed of polymers from different polymer classes (e.g., nylon and polypropylene) or be formed of polymers from the same polymer class (e.g., nylon) but which differ in their properties or characteristics. The term "multicomponent fiber" is thus intended to include, but is not limited to, concentric and eccentric sheath-core fiber structures, symmetric and asymmetric side-by-side fiber structures, island-in-sea fiber structures, pie wedge fiber structures, and hollow fibers of these configurations.

Although the substrates depicted in the various cross-sectional views of the present invention are illustrated as single layer structures, it should be understood that the substrates may be of single or multi-layer construction. If a multi-layer construction is used, it will be understood that the various layers may have the same or different properties, constructions, etc. Some of these variations may be as described in, for example, pending U.S. Patent Application Serial No. 09/257,447, entitled WEB HAVING DISCRETE STEM REGIONS, filed on Feb. 25, 1999 (published as International Publication No. WO 00/50229).

The discrete polymeric regions 14 may be formed of a wide variety of different thermoplastic polymeric materials. The thermoplastic compositions used in connection with the methods of the present invention should be capable of flowing or entering into depressions formed in a polymer transfer roll as will be described below. Furthermore, it may be desirable that the thermoplastic compositions also exhibit a relatively high degree of moldability, i.e., the ability to take the shape of a cavity when subjected to the proper conditions of temperature and pressure.

Suitable thermoplastic compositions are those that are melt processable. Such polymers are those that will flow sufficiently to at least partially fill the depressions, yet not significantly degrade during a melt process. A wide variety of thermoplastic compositions have suitable melt and flow characteristics for use in the process of the present invention depending on the geometry of the depressions and the processing conditions. It may further be preferred that the melt processable materials and conditions of processing are selected such that any viscoelastic recovery properties of the thermoplastic compositions do not cause it to significantly withdraw from the wall(s) of the depressions until transfer of the thermoplastic composition to a substrate is desired.

As used in connection with the present invention, "thermoplastic" (and variations thereof) means a polymer or polymeric composition that softens when exposed to heat and returns to its original condition or near its original condition when cooled to room temperature.

Some examples of thermoplastic compositions that may be used in connection with the present invention include, but are not limited to, polyurethanes, polyolefins (e.g., polypropylenes, polyethylenes, etc.), polystyrenes, polycarbonates, polyesters, polymethacrylates, ethylene vinyl acetate copolymers, ethylene vinyl alcohol copolymers, polyvinylchlorides, acrylate modified ethylene vinyl acetate polymers, ethylene acrylic acid copolymers, nylons, fluorocarbons, etc. These materials can be elastomeric or nonelastomeric (e.g., polycarbonates, polymethacrylates, and polyvinylchlorides)

An elastomeric (or elastic) thermoplastic polymer is one that melts and returns to its original condition or near its original condition upon cooling and exhibits elastomeric properties at ambient conditions (e.g., room temperature and pressure). As used in connection with the present invention, "elastomeric" means that the material will substantially resume its original shape after being stretched. Further, the elastomeric materials may preferably sustain only small permanent set following deformation and relaxation which set is preferably no greater than about 30 percent and more preferably no greater than about 20 percent of the original length at moderate elongation, e.g., about 50%. The elastomeric materials can be both pure elastomers and blends with an elastomeric phase or content that will still exhibit substantial elastomeric properties at room temperature. U.S. Patent No. 5,501,679 (Krueger et al.) provides some further discussion regarding elastomeric materials that may be considered for use in connection with the present invention.

The elastic thermoplastic polymers can include one or more polymers. For example, the polymer could be a blend with an elastomeric phase such that the polymer exhibits elastomeric properties at room temperature. Suitable elastic thermoplastic polymers include block copolymers such as conventional A-B or A-B-A block copolymers (e.g., styrene-isoprene-styrene, styrene-butadiene-styrene, styrene-ethylene-butylene-styrene block copolymers), elastomeric polyurethanes, olefinic elastomers, particularly elastomeric ethylene copolymers (e.g., ethylene vinyl acetates, ethylene/octene copolymer elastomers, ethylene/propylene/diene terpolymer elastomers), as well as mixtures of these with each other, with other elastic thermoplastic polymers, or with nonelastic thermoplastic polymers.

The thermoplastic compositions used in connection with the present invention can also be combined with various additives for desired effect. These include, for example, fillers, viscosity reducing agents, plasticizers, tackifiers, colorants (e.g., dyes or pigments), antioxidants, antistatic agents, bonding aids, antiblocking agents, slip agents, stabilizers (e.g., thermal and ultraviolet), foaming agents, microspheres, glass bubbles, reinforcing fibers (e.g., microfibers), internal release agents, thermally conductive particles, electrically conductive particles, and the like. The amounts of such materials that can be useful in the thermoplastic compositions can be readily determined by those skilled in the art of processing and using such materials.

FIG. 2 depicts another embodiment of a composite web manufactured in accordance with the present invention that includes a substrate 110 on which a plurality of discrete polymeric regions 114 are located. The discrete polymeric regions 114 also include a plurality of stems 112 protruding from a base 113. One difference between the embodiment of FIG. 2 and the embodiment of FIG. 1 is in the orientation of the protruding stems 112 (in FIG. 2). The stems 12 depicted in FIG. 1 are oriented substantially perpendicular to the substrate 10. In contrast, the stems 112 depicted in FIG. 2, are oriented at an acute angle relative to the substrate 110.

The orientation of the stems 112 may be advantageous for a number of reasons. For example, the angled stems 112 may not require a cap or other structure to engage a loop surface or other fibrous substrate adapted to engage the stems 112. The composite web depicted in FIG. 2 may exhibit the ability to fasten to a loop or other surface in a selected direction while releasing when the web is moved in the opposite direction. Such a construction may be particularly useful in connection with an elastic substrate. Although the stems 112 are all shown as being angled in the same direction, it should be understood that the stems provided on a single substrate could be angled in different directions.

The orientation of the stems 112 depicted in FIG. 2 may be provided in a variety of manners. For example, the stems 112 may be manufactured using a tool having holes or cavities that are angled or tilted in the desired direction or directions. Examples of such tools may be described in, for example, U.S. Patent No. 5,792,411 (entitled LASER MACHINED REPLICATION TOOLING), U.S. Patent No. 6,190,594 B1 (entitled TOOLING FOR ARTICLES WITH STRUCTURED SURFACES), etc.

FIG. 3 is a plan view of the composite web of FIG. 2 including a plurality of discrete polymeric regions 114' located on the major surface 118' of a substrate 110'. Although the discrete polymeric regions 114 are shown as being uniformly spaced over the surface of the substrate in a regular, repeating pattern (in both the x and y directions), it should be understood that spacing between the discrete polymeric regions 114 may be non-uniform if so desired. Furthermore, the pattern in which the discrete polymeric regions are arranged, may be irregular and/or non-repeating.

In other variations, portions of the composite webs manufactured in accordance with the present invention may include uniformly-spaced discrete polymeric regions as depicted in FIG. 3 while other portions of the same composite web may be free of any discrete polymeric regions. In yet another alternative, portions of the composite web manufactured in accordance with the present invention may include uniformly spaced discrete polymeric regions as seen in FIG. 3, while other portions of the same composite web may include discrete polymeric regions that are arranged in a non-uniform and/or non-repeating patterns. Further, different portions of a composite web manufactured according to the present invention may include different sets of discrete polymeric regions that are both uniformly spaced in repeating patterns that are different from each other.

Further, the discrete polymeric regions could be provided in any desired shape, e.g., squares, rectangles, hexagons, etc. The shapes may or may not be in the form of recognized geometric shapes, but may be randomly formed with irregular perimeters. In addition, the shapes may not necessarily be solid figures, but may include voids formed within the shape in which none of the thermoplastic composition is transferred. In yet another alternative, some or all of the discrete polymeric regions may be in the form of indicia, i.e., letters, numbers, or other graphic symbols.

The composite web depicted in the cross-sectional view of FIG. 4 illustrates yet another variation in connection with composite webs manufactured in accordance with the present invention. The composite web of FIG. 4 includes a substrate 210 on which discrete polymeric regions 214 are located. The discrete polymeric regions 214 include a plurality of stems 212 formed thereon and protruding from a base 213. Each of the stems 212 further includes a cap 211. Capped stems are known in the art of mechanical fasteners and may be formed by any of a wide variety of processes. Some of the suitable processes are described in, for example, U.S. Patent Nos. 5,077,870 (Melbye et al.), 5,868,987 (Kampfer et al.), 6,039,911 (Miller et al.), and 6,132,660 (Kampfer).

Referring now to FIG. 5, a portion of another composite web manufactured in accordance with the present invention is depicted which includes a plurality of discrete polymeric regions 314 located on a substrate 310. The discrete polymeric regions 314 include hook structures 312 protruding from a base 313 attached to the substrate 310. The bases 313 are depicted as tapering smoothly at their edges which may serve to soften the edges of the discrete polymeric regions 314. In spite of the tapered edges, the discrete polymeric regions 314 are still separated by some portion 316 of the surface 318 of the substrate 310. FIG. 6 depicts yet another variation in a composite web according to the present invention. The variation depicted in Fig. 6 includes a substrate 410 on which a discrete polymeric region 414 is located. The discrete polymeric region 414 includes a number of structures 412 protruding from a base 413. The protruding structures 412 may be in the form of pyramids or cones that may, e.g., provide some abrasive properties to the composite web.

Another feature depicted in FIG. 6 is that the base 413 of the discrete polymeric region 414 may include one or more notches 415. Such notches 415 may improve the flexibility and/or conformability of the composite webs of the present invention because of the ability of the base 413 to flex in response to bending stresses on the composite web. Still another variation depicted in FIG. 6 is that the different portions (A & B in FIG. 6) may include different numbers of structures 412 at different spacing. Another variation is that the height of the structures 412 above the base 413 and/or substrate 410 also varies in the different portions of the discrete polymeric region 414.

FIG. 7 illustrates yet another embodiment of a composite web manufactured in accordance with the present invention. The composite web includes a substrate 510 with opposing major surfaces 518 and 519. One feature illustrated in FIG. 7 is the two-sided nature of the discrete polymeric regions located on the opposing major surfaces 518 and 519, respectively.

Discrete polymeric regions 514a and 514b are provided on major surface 518 and each include structures 512 protruding from a base 513 attached to the substrate 510. Discrete polymeric regions 524a and 524b are provided on opposing major surface 519 and include stems 522 that terminate in caps 521.

The discrete polymeric regions on opposing major surfaces are depicted as being in registration through the substrate 510. In other words, the discrete polymeric regions 514a and 514b are aligned with the discrete polymeric regions 524a and 524b on the opposite side of the substrate 510. Further, the discrete polymeric regions 514a and 514b are depicted as being substantially the same size as the discrete polymeric regions 524a and 524b located on the opposite side of the substrate 510. It should, however, be understood that when a composite web having discrete polymeric regions on both major surfaces is desired, the discrete polymeric regions on the opposing surfaces may or may not be the same size as seen in FIG. 7. Also, it should be understood that the discrete polymeric regions may or may not be in registration with each other through the substrate 510 as seen in FIG. 7.

FIG. 8 is a perspective view of one system and method of providing discrete polymeric regions on one surface of a substrate 10 in accordance with the principles of the present invention. The system depicted in FIG. 8 includes a substrate 10 that defines a web path through the system. The substrate 10 moves through the system in a downstream direction indicated by the rotation arrows on the various rolls. After being unwound or otherwise provided from a supply (e.g., the substrate 10 may be manufactured in-line with the system depicted in

FIG. 8), the substrate 10 is directed into a transfer nip formed between a backup roll 20 and a transfer roll 30.

The process of providing discrete polymeric regions on the substrate 10 includes delivering a supply of a molten thermoplastic composition to the exterior surface 32 of transfer roll 30 that includes a one or more depressions 34 formed in its exterior surface 32. The molten thermoplastic composition 41 is supplied to the exterior surface 32 of the transfer roll 30 by a delivery apparatus in the form of a trough 40 (or other supply apparatus, e.g., extruder, gear pump, etc.). The excess molten thermoplastic composition is wiped or removed from the exterior surface 32 by a doctor blade 42 acting against the exterior surface 32 of the transfer roll 30. Although it may be ideal to remove all of the thermoplastic composition from the exterior surface 32 of the transfer roll 30, some of the thermoplastic composition may remain on the exterior surface 32 after wiping by the doctor blade 42.

The depressions 34 formed in the exterior surface 32 of the transfer roll 30 preferably receive a portion of the molten thermoplastic composition when the molten thermoplastic composition is deposited on the exterior surface 32 of the transfer roll 30. If the depressions 34 are not completely filled during or by the deposition of molten thermoplastic composition, the wiping action of the doctor blade 42 on the exterior surface 32 of the transfer roll 30 may assist in substantially filling the depressions with molten thermoplastic composition.

Control over the temperatures of the various rolls in the system depicted in FIG. 8 may be useful in obtaining the desired products. It may be preferred, e.g., that the exterior surface 32 of the transfer roll 30 be heated to a selected temperature that is at or above the melt temperature of the thermoplastic composition to be transferred to the substrate 10. Heating the transfer roll 30 may also enhance filling of the depressions 34 by the molten thermoplastic composition.

Because the molten thermoplastic composition 41 is itself heated within the trough 40, the doctor blade 42 will typically be heated by the molten thermoplastic composition. It may alternatively be desirable to control the temperature of the doctor blade 42 separately from the trough 40 containing the molten thermoplastic composition 41. For example, it may be desirable to heat the doctor blade 42 to a temperature above the melt temperature of the molten thermoplastic composition.

FIG. 8A is an enlarged partial cross-sectional view depicting one relationship between a doctor blade 42 and depression 34 in a transfer roll 30. Another characteristic of the doctor blade 42 that may be controlled is its thickness or length 43 along the exterior surface of the transfer roll 30 (as measured in the machine direction or the direction of rotation of the transfer roll). For example, a thicker or longer doctor blade 42 may help by allowing the molten thermoplastic composition more time to relax within the depressions 34, thereby improving filling of the depressions. In addition to varying the length of the doctor blade 42, the pressure or force exerted on the transfer roll 30 by the doctor blade 42 may also be adjusted based on a variety of factors including, e.g., the characteristics of the molten thermoplastic composition, the transfer roll characteristics, etc.

With the depressions 34 at least partially filled with the desired molten thermoplastic composition, the transfer roll 30 continues to rotate until the depressions 34 and the molten thermoplastic composition they contain are forced into contact with the substrate 10 against backup roll 20 at the transfer nip (i.e., the nip formed by the transfer roll 30 and the backup roll 20. It is at this point that transfer of the molten thermoplastic composition in the depressions 34 to the substrate 10 begins. It should be understood that under certain conditions, only a portion of the thermoplastic composition in the depressions 34 may transfer to the substrate 10.

When a substrate 10 that includes one or more porous major surfaces on which the molten thermoplastic composition is deposited is used in connection with the methods of the present invention, a mechanical bond is preferably formed by infiltration of the molten thermoplastic composition into the porous surface of the substrate 10. As used in connection with the present invention, the term "porous" includes both structures that include voids formed therein, as well as structures formed of a collection of fibers (e.g., woven, nonwoven, or knit) that allow for the infiltration of molten thermoplastic compositions.

The nip pressure between the transfer roll 30 and the backup roll 20 is preferably sufficient such that a portion of the thermoplastic composition in the discrete polymeric regions infiltrates and/or encapsulates a portion of the porous substrate 10 to improve attachment of the discrete polymeric regions to the substrate 10. Where the surface of the substrate 10 includes fibers (e.g., where the substrate 10 includes woven, nonwoven, or knit materials on its major surfaces), it may be preferred that the thermoplastic composition encapsulate all or a portion of at least some of the fibers on the surface of the substrate 10 to improve attachment of the discrete polymeric regions to the substrate 10.

Under some conditions the molten thermoplastic composition in the depressions 34 may completely permeate the substrate 10 if, e.g., the substrate 10 is porous throughout its thickness. In other instances, penetration of the molten thermoplastic composition may be limited to the outer layer or layers of the substrate 10.

It should, however, be understood that although the outer surfaces of the substrate 10 may exhibit some porosity, that porosity may not necessarily extend through the entire thickness of the substrate 10. For example, the substrate 10 may have a variety of different layers, with one of the layers being substantially non-porous. In another alternative, the overall thickness of the substrate 10 may render it non-porous as a whole, even though the outer surfaces of the substrate 10 exhibit some porosity as discussed above.

The backup roll 20 may possess a variety of different characteristics depending on the types of substrate materials and/or molten thermoplastic compositions being processed. In some instances, the exterior of the backup roll 20 may be a rubber or other conformable material that conforms to the shape of the transfer roll 30. If a conformable material such as rubber is used, it may, e.g., have a durometer of, e.g., about 10-90 Shore A.

One such variation at the transfer nip is depicted in FIG. 8B, in which a conformable backup roll 130 is depicted as forcing a portion of the substrate 110 into the depression 134 (and the thermoplastic composition 141 contained therein). If the surface of the substrate 110 facing the depression 134 is porous, a portion of the molten thermoplastic composition 141 may infiltrate the porous surface of the substrate 110. Forcing the substrate 110 into the depression may be particularly beneficial if the depression 134 is not completely filled with the molten thermoplastic composition 141 to improve the likelihood of contact between the substrate 10 and the molten thermoplastic composition 141.

Alternatively, the surface of the substrate may be forced into the depressions on the transfer roll using a mating backup roll. This variation at the transfer nip is depicted in FIG. 8C in which the backup roll 220 includes protrusions 222 that are complementary to or mate with the depressions 234 on the transfer roll 230. The protrusions 222 would preferably force a substrate into the depressions with the same results and benefits described above with respect to FIG. 8B. A mating backup roll 220 could be formed of any conformable material, nonconformable material, or combination of conformable or nonconformable materials.

Heating or otherwise controlling the temperature of the transfer roll is discussed above. It should also be appreciated that the temperature of the exterior surface of the backup roll may be controlled. For example, it may be desirable to cool the surface of the backup roll to a selected temperature below the temperature of the transfer roll. Cooling of the backup roll may be beneficial in maintaining the integrity of the substrate, particularly if the substrate integrity can be degraded from the heat of the transfer roll (if the transfer roll is heated) and/or the molten thermoplastic composition in the depressions of the transfer roll.

The substrate 10 continues around the backup roll 20 as seen in FIG. 8. In some instances, a portion of the molten thermoplastic composition in the depressions may remain in the depressions 34 while the substrate 10 is pulled away from the transfer roll 30. As a result, the molten thermoplastic composition in the depressions 34 may tend to elongate or string between the depressions in transfer roll 30 and the substrate 10.

A device, such as a hot wire 44 seen in FIG. 8, may be used to sever any strands of thermoplastic composition that may be formed as the substrate 10 separates from the transfer roll 30. Other devices and/or techniques may be used to accomplish the desired severing of any molten thermoplastic composition strands. Examples may include, but are not limited to hot air knives, lasers, etc. Furthermore, under certain conditions, stringing of the thermoplastic composition may not be encountered during manufacturing.

The tendency of the molten thermoplastic composition in the depressions 34 to string as the substrate exits the transfer nip also raises another issue that should be considered when developing processes according to the present invention. That issue is the internal cohesive strength of the substrate 10 and/or the tensile strength of the substrate 10. This issue may be of more concern if the substrate 10 includes a fibrous construction (e.g., woven, nonwoven, or knit fibers) that could be separated from the remainder of the substrate by the forces exerted when the substrate 10 is pulled away from the transfer roll 30. These considerations may be more important if the molten thermoplastic composition has properties (e.g., tackiness, tensile strength, etc.) such that strands of the molten thermoplastic composition can exert forces on the substrate 10 that exceed the internal cohesive strength and/or tensile strength of the substrate 10.

For example, if the substrate 10 includes a resin-bonded nonwoven portion, the temperature of the transfer roll 30 and/or molten thermoplastic composition may rise above the melting temperature of the resin, thereby potentially degrading the internal cohesive strength and/or tensile strength of the substrate 10. Alternatively, a nonwoven substrate may include fibers that have a melting temperature similar to the temperature of the transfer roll 30 and/or molten thermoplastic composition, thereby potentially degrading the internal cohesive strength and/or tensile strength of the substrate 10.

In either instance, the roll temperatures and/or molten thermoplastic composition temperature may need to be controlled to maintain the integrity of the substrate while transferring the molten thermoplastic composition. For example, the backup roll 20 may be cooled to, in turn, cool the substrate 10 to maintain its internal cohesive strength.

In another alternative, heating of the transfer roll 30 and/or backup roll 20 may be used to enhance the internal cohesive strength and/or tensile strength of the substrate 10. For example, if the substrate 10 includes multi-component fibers or fibers having different compositions, some consolidation of the fibers or other components in the substrate 10 may be caused by heating the substrate 10 while transferring the molten thermoplastic composition from the transfer roll 30 to the substrate 10. That consolidation may improve the integrity of the substrate by forming a skin layer or other strength-enhancing structure on or within the substrate 10. Some exemplary processes may be described in, e.g., U.S. Patent No. 5,470,424 (Isaac et al.).

The system and method depicted in FIG. 8 also includes a forming tool 50 which, in the depicted embodiment, also acts against backup roll 20 to provide a forming nip that is downstream of the transfer nip in the depicted system. Although the forming tool 50 is depicted as providing the forming nip with that same backup roll 20 used to form the transfer nip (with transfer roll 30), it will be understood that the forming nip could be provided by positioning the forming tool 50 to form a nip with a different roll. Using the same backup roll for both the transfer nip and the forming nip, may, however, be beneficial in that fewer system components and/or floorspace may be required for the system.

In systems and methods where the transfer nip and the forming nip are separated, i.e., they are not located on the same backup roll 20, it will be understood that the two processes, i.e., transferring and forming, may be separated in time and/or space. If the transferring nip and the forming nip are separated from each other such that the thermoplastic composition in the discrete polymeric regions is no longer sufficiently molten to form structures in the forming nip, the discrete polymeric regions on the substrate may need to be heated before passing through the forming nip. For example, the discrete polymeric regions could be deposited on a substrate which could then be wound into a roll. The wound substrate with discrete polymeric regions could then be unwound later and directed into a forming nip after heating (by contact or noncontact heat sources).

The forming tool 50 is provided in the form of a roll and includes cavities 52 formed in its surface. Forming tools such as that depicted in FIG. 8 are well known to those of skill in the art. Some forming tools are described in, for example, U.S. Patent Nos. 4,984,339 (Provost et al.), 5,077,870 (Melbye et al.), 5,755,015 (Akeno et al.), 5,868,987 (Kampfer et al.), 6,132,660 (Kampfer), 6,190,594 B1 (Gorman et al.), 6,287,665 B1 (Hammer), etc.

The forming tool 50 and/or backup roll 20 may be heated or cooled to a selected temperature based on the properties of the thermoplastic composition being formed to enhance forming of the discrete polymeric regions by the cavities 52 in the forming tool 50. For example, it may be desirable to heat or cool the forming tool 50 to enhance the forming process. Depending on the speed of the process and other factors, the discrete regions of thermoplastic composition located on substrate 10 may also advantageously retain some of their molten nature as transferred to the substrate 10.

In any event, a portion of the thermoplastic composition in discrete polymeric regions 14 located on the substrate 10 enters the cavities 52 on the forming tool 50. As a result, structures such as the stems depicted in FIGS. 1 & 2 may be formed in the discrete polymeric regions 14 located on substrate 10.

In some instances, the thermoplastic composition provided in discrete regions on the substrate 10 may possess properties (e.g., viscosity, etc.) such that the thermoplastic composition replicates the shape of the cavities 52 provided in the forming tool 50. As used herein, the term "replicates" (and variations thereof) includes complete replication as well as partial replication of the shape of the cavities 52 by the thermoplastic composition. In other instances, the properties (e.g., viscosity, etc.) may result in forming of the thermoplastic composition on the substrate 10 into shapes that, although they differ from the shape of the thermoplastic composition before forming by the forming tool 50, do not replicate the shape of the cavities 52 as described above.

FIG. 8D is a schematic diagram of another system according to the present invention. The system of FIG. 8D includes a supply 615 of substrate 610 directed into a transfer nip 630. A molten thermoplastic composition delivery apparatus 640 provides molten thermoplastic composition to the transfer nip 630 which preferably includes a transfer roll with depressions and a wiping apparatus (e.g., doctor blade) as described above.

At the transfer nip 630, discrete polymeric regions 614 are transferred to the substrate 610 which is then directed into a forming nip 650 that preferably includes a forming tool (e.g., as described above) to form structures 612 protruding from a base 613 of the discrete polymeric regions 614.

The substrate 610 with structured polymeric regions 614 can then, optionally, be directed into a deforming station 660 at which the structures 612 formed at the forming nip 650 are deformed. The deforming station 660 may, for example, perform a variety of processes to deform the structures 612 after they are formed at the forming nip 650. Examples of some suitable processes that may be performed at the deforming station include, but are not limited to, trimming, shaving, abrading heating or melting (using a contact or noncontact heat source), bending or otherwise distorting the structures. Where the structures 612 are stems, the deforming may include, e.g., forming a cap on the stem, forming a hook on a stem, bending the stem, etc. Some potential apparatus and processes are described in, for example, U.S. Patent Nos. 5,077,870 (Melbye et al.), 5,868,987 (Kampfer et al.), 6,039,911 (Miller et al.), 6,054,091 (Miller et al.), and 6,132,660 (Kampfer).

Although the system and method depicted in FIG. 8 produces composite webs with discrete polymeric regions on only one major side thereof, those of skill in the art will recognize the modifications required to provide discrete polymeric regions on both major surfaces of the substrate in accordance with the principles of the present invention. One example may include, e.g., forming discrete polymeric regions on one surface of each of two separate substrates, with the two substrates then being laminated together to form a single substrate with discrete polymeric regions on both major surfaces (see, e.g., FIG. 7). Alternatively, a single substrate may be directed into a nip formed by two transfer rolls, with each of the transfer rolls depositing discrete polymeric regions on both sides of the web essentially simultaneously.

Although FIG. 8 depicts the application of only one thermoplastic composition using the transfer roll 30, it will be understood that two or more different thermoplastic compositions may be applied to the exterior surface of the transfer roll 30. FIG. 9 depicts a portion of one system in which a trough 340 is used to deliver three molten thermoplastic compositions (in zones A, B, & C) to the surface of a transfer roll 330 that rotates about an axis 331. The trough 340 may, for example, include barriers 342 such that molten thermoplastic compositions in the different zones of the trough 340 do not mix during processing. In another alternative, separate and distinct troughs could be used for each different thermoplastic composition to be applied to the transfer roll 330.

The transfer roll 330 also includes different sets of depressions 334a, 334b, and 334c over which the different molten thermoplastic compositions may be applied. The depressions in the different zones on transfer roll 330 are differently shaped, have different sizes, and have different spacings. For example, the triangular depressions in zone C are arranged in an irregular, non-repeating pattern while the depressions in zones A & B are arranged in regular, repeating patterns.

With the system of FIG. 9, different sets of discrete polymeric regions may be formed on a single substrate using different thermoplastic compositions. As a result, the thermoplastic compositions may be selected for any of a number of different properties related to manufacturing or end-use performance of the finished articles made using the composite webs.

FIG. 10 is a plan view of one exemplary depression 34 in transfer roll 30 of the present invention, while FIG. 11 is a cross-sectional view of the depression 34 taken along line 11-11 in FIG. 10. The depression 34 has a circular footprint (i.e. shape of the opening into the depression 34 at the surface 32 of the roll) with a diameter represented by the letter *d*. The depression 34 has a depth (represented by the letter *h*) measured from the exterior surface 32 of the transfer roll 30.

Transfer rolls used in connection with the present invention preferably include depressions that are large enough to form discrete polymeric regions of sufficient size to support, for example, the formation of multiple stems or other structures in each of the discrete polymeric regions. The depressions may be characterized in a variety of manners. For example, the depressions 34 may be characterized in terms of the area occupied by their footprint on the exterior surface of the forming tool, a maximum dimension of the footprint (in any direction on the surface of the roll), the volume of the depression, the shape of the footprint, etc.

When characterized in terms of the area occupied by the footprint of the depressions, each of the depressions 34 may have a footprint with an area of about 4 square millimeters (mm^2) or more. In other situations, each of the depressions 34 may have footprints with an area of about 8 mm^2 or more.

Another manner in which the depressions may be characterized is in terms of the largest footprint dimension as measured on the surface 32 of the transfer roll 30. For a depression with a circular footprint as seen in FIGS. 10 and 11, the largest dimension is the same in all directions, but the depressions used in connection with the present invention may take any desired shape (e.g. elongated, irregular, etc.) in which the largest dimension will occur in one or more directions on the exterior surface of the transfer roll 30, but not in others. When characterized in terms of the largest footprint dimension, it may be that the depressions have a largest footprint dimension of about 2 mm or more, in some instances about 5 mm or more.

Yet another manner in which the depressions used in connection with the present invention may be characterized is in terms of volume. For example, the depressions may have a depression volume of at least about three (3) cubic millimeters (mm^3) or more, or alternatively, a depression volume of about five (5) cubic millimeters. Volume of the discrete polymeric regions may be important to provide enough of the thermoplastic composition to adequately enter the cavities in a forming tool. Depression volume may also be important because at least some of the molten thermoplastic composition may be retained within the depression during the transfer process, i.e., the depression volume may preferably be oversized relative to the preferred volume of the discrete polymeric regions to compensate for retention of thermoplastic composition within the depressions.

FIG. 12 depicts two depressions 234 formed in an exterior surface 232 of a transfer roll, with FIG. 13 being a cross-sectional view of one of the depressions 234 taken along line 13-13 in FIG. 12. The depressions 234 have elongated shapes in the form of, e.g., a trough. When compared to the circular depression 34 seen in FIGS. 10 and 11, the longer depressions 234 of FIGS. 12 and 13 would have a larger footprint dimension along their elongated direction than transverse to their elongated direction.

The orientation of the depressions 234 may be selected based on a variety of factors. The elongated depressions 234 may be aligned in the machine direction (i.e., the direction of travel of a substrate), in the cross-web direction (i.e., transverse to the direction of travel of the substrate), or any other orientation between machine direction or cross-web direction.

FIGS. 14 & 15 depict another variation associated with the methods of manufacturing composite webs according to the present invention. FIG. 14 depicts, in a plan view, a portion of a composite web manufactured according to the present invention. The composite web includes a substrate 310 on which two discrete polymeric regions 314 and 315 are located. The backing includes two opposing edges 311 that extend over the length of the composite web and, together, define the longitudinal length of the composite web.

Discrete polymeric region 314 is provided in the shape of a line of the thermoplastic composition material deposited on the substrate 310 along the general direction of the longitudinal length of the composite web. The discrete polymeric region 314 may be continuous along the longitudinal length of the composite web as shown in FIG. 14.

Discrete polymeric region 315 is a variation of discrete polymeric region 314 in that it is provided in an undulating shape as compared to the relative straight linear shape of the discrete polymeric region 314. The undulating shape of the discrete polymeric region 315 also, however, extends along the direction of the longitudinal length of the composite web. Further, the discrete polymeric region 315 may be continuous along the longitudinal length of the composite web as shown in FIG. 14.

FIG. 15 is a perspective view of one transfer roll 330 that may be used to transfer thermoplastic compositions in the shapes seen in FIG. 14 according to the methods of the present invention. The transfer roll 330 includes a depression 334 that preferably extends continuously around the outer circumference of the roll 330 to form the discrete polymeric region 314 as depicted in FIG. 14. The transfer roll 330 also includes a depression 335 that also extends around the outer circumference of the roll 330 to form the discrete polymeric region 315 as depicted in FIG. 14.

FIG. 16 depicts another variation associated with the methods of manufacturing composite webs according to the present invention. FIG. 16 depicts, in a plan view, a portion of a composite web manufactured according to the present invention. The composite web includes a substrate 410 on which discrete polymeric regions 414a, 414b, and 414c are located, with the discrete polymeric regions extending across the width of the substrate. The substrate 410 includes two opposing edges 411 that extend over the length of the composite web and, together, define the width and the longitudinal length of the composite web.

Each of the discrete polymeric regions 414a, 414b, and 414c is provided in the shape of a line of the thermoplastic composition material deposited on the substrate 410 in a generally cross-web direction, i.e., extending between the opposing edges 411 of the substrate 410. The discrete polymeric regions 414a, 414b, and 414c present variations from straight lines 414a and 414b to undulating line 414c. Many other variations in placement, shape and/or orientation of discrete polymeric regions may be envisioned in connection with methods according to the present invention.

In addition to the deposition of thermoplastic polymer in discrete regions, it is also contemplated that additional materials can be coated onto a major surface of the substrate using known methods. Such materials could be, for example adhesives, as described in, e.g., U.S. Patent Nos. 5,019,071 (Bany et al.); 5,028,646 (Miller et al.); and 5,300,057 (Miller et al.); or cohesives as described in, e.g. U.S. Patent Nos. 5,389,438 (Miller et al.) and 6,261,278 (Chen et al.).

EXAMPLES

The following examples are provided to enhance understanding of the present invention. They are not intended to limit the scope of the invention.

Example 1

A web of the present invention was produced using apparatus similar to that shown in Fig. 8. A 5 cm diameter single screw extruder was used to deliver molten ultra low density polyethylene (ENGAGE 8402, 30 MI, DupontDow Elastomers), pigmented with 1.5% of a yellow polyolefin-based color concentrate, at a melt temperature of approximately 273^{O}C to a strand die 40 having 5 orifices spaced 25 mm apart across the die tip. Each orifice was 2.0 mm in diameter. The strands of molten polymer were extruded vertically downward onto the exterior surface 32 of an oil-heated steel transfer roll 30 having a diameter of 23 cm. The exterior surface of the transfer roll was machined using a computer controlled milling machine to have truncated hemispherical depressions 2.3 mm in diameter and 1.3 mm in depth, having a volume of 2.2

mm^3 and an area of 3.2 mm^2 arranged in a staggered array with center-to-center spacing between depressions of 5.1 mm resulting in 3.9 depressions/cm^2 across the exterior surface of the transfer roll.

After the depressions were filled or partially filled with the molten polymer, any excess molten polymer was removed from the exterior surface of the transfer roll by a brass doctor blade 42 having a thickness of 1.5 mm, acting against and normal to the exterior surface of the transfer roll at a pressure of 131 N/lineal cm. The excess molten polymer formed a small rolling bank of polymer contained in a trough formed by the doctor blade and two side walls pressed snugly against the transfer roll. The transfer roll was at approximately 176^{O}C.

After the wiping action of the doctor blade, the transfer roll continued to rotate until the depressions and the molten polymer they contain were forced into contact with a nonwoven substrate 10 (10 gram/m^2 CEREX PBN-II nylon spunbond, Cerex Advanced Fabrics) against a rubber backup roll 20 (121^{O}C) using a nip pressure of 105 N/lineal cm. Transfer of some of the molten polymer from the depressions to the nonwoven substrate occurred.

A portion of the molten polymer in the depressions remained in the depressions while the substrate pulled away from the transfer roll. As a result, the molten polymer tended to elongate or string between the depressions in the transfer roll and the substrate. A hot wire 44 was used to sever any strands of molten polymer formed as the substrate separated from the transfer roll. The basis weight of each transferred molten polymer region was 92.5 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 7.5 grams/m^2.

After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 35 N/lineal cm, formed by the rubber backup roll and a forming roll 50 (38^{O}C). The forming roll consisted of a silicone rubber sleeve on a steel roll. The rubber sleeve contained cavities formed by a laser beam as described in commonly assigned US Pat. 5,792,411, with diameters of about 0.1 mm, depths of about 1.0 mm and spacing of about 1.0 mm (MD) and 0.5 mm (CD), resulting in about 194 cavities/cm^2 . The cavities were angled at 45 degrees from the tangent of the roll surface in alternating directions with half of the cavities angled upstream in the machine direction, and half of the cavities angled downstream in the machine direction, each cavity in a given row, alternating in direction with the adjacent cavity in the same row. A portion of the transferred molten polymer in each of the discrete polymer regions 14 was forced into the cavities 52 on the forming. As a result, structures such as the stems depicted in Fig. 2 were formed in the discrete polymeric regions located on the substrate. The height of the stems, measured normal to the surface of the base polymer region was 280 microns.

Example 2

To demonstrate the use of a transfer roll having larger sized depressions, a web was prepared as in Example 1 except the exterior surface of the transfer roll was machined using a computer controlled milling machine to have elongated hemispherical depressions 2.3 mm in diameter and 2.3 mm in depth, having a volume of 6.6 mm^3 and an area of 3.2 mm^2 arranged in a staggered array with center-to-center spacing between depressions of 5.1 mm resulting in 3.9 depressions/cm^2 across the exterior surface of the transfer roll. The basis weight of each transferred molten polymer region was 102 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 8.0 grams/m^2. The temperature of the backup roll was approximately 121^{O}C and the temperature of the forming roll was approximately 38^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 280 microns.

Example 3

To demonstrate the use of a transfer roll having larger sized depressions, a web was prepared as in Example 1 except the exterior surface of the transfer roll was machined using a computer controlled milling machine to have elongated hemispherical depressions 2.5 mm in diameter and 2.5 mm in depth, having a volume of 12.9 mm^3 and an area of 5.1 mm^2 arranged in a staggered array with center-to-center spacing between depressions of 5.1 mm resulting in 3.9 depressions/cm^2 across the exterior surface of the transfer roll. The basis weight of each transferred molten polymer region was 221 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 28 grams/m^2. The temperature of the backup roll was approximately 121^{O}C and the temperature of the forming roll was approximately 38^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 381 microns.

Example 4

To demonstrate the use of a different polymer, a web was prepared as in Example 1 except a linear low density polyethylene (ASPUN 6806, 100 MI, Dow Chemical) pigmented with 1.5% of a red polyolefin-based color concentrate (1053237, Clariant Corp.), was used at a melt temperature of approximately 190^{O}C The basis weight of each transferred molten polymer region was 86 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 6.7 grams/m^2. The temperature of the backup roll was approximately 121^{O}C and the temperature of the forming roll was approximately 38^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 230 microns.

Example 5

To demonstrate the use of a transfer roll having larger sized depressions, a web was prepared as in Example 4 using the transfer roll described in Example 2. The basis weight of each transferred molten polymer region was 200 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 17 grams/m^2. The temperature of the backup roll was approximately 121^{O}C and the temperature of the forming roll was approximately 38^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 267 microns.

Example 6

To demonstrate the use of a transfer roll having larger sized depressions, a web was prepared as in Example 4 using the transfer roll described in Example 3. The basis weight of each transferred molten polymer region was 298 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 37 grams/m^2. The temperature of the backup roll was approximately 121^{O}C and the temperature of the forming roll was approximately 38^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 330 microns.

Example 7

To demonstrate the use of a different polymer, a web was prepared as in Example 1 except a polyurethane (PS164-400, Huntsman Chemical) pigmented with 1.5% of a green polyolefin-based color concentrate (1030629, Clariant Corp.), was used at a melt temperature of approximately 207^{O}C. A nip pressure of 70 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. The basis weight of each transferred molten polymer region was 86 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 6.7 grams/m^2. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 44 N/lineal cm, formed by a rubber backup roll and a forming roll. The temperature of the backup roll was approximately 93^{O}C and the temperature of the forming roll was approximately 38^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 229 microns.

Example 8

To demonstrate the use of a transfer roll having larger sized depressions, a web was prepared as in Example 7 using the transfer roll described in Example 2. The basis weight of each transferred molten polymer region was 200 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 17 grams/m^2. The temperature of the backup roll was approximately 93^{O}C and the temperature of the forming roll was approximately 38^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 254 microns.

Example 9

To demonstrate the use of a transfer roll having larger sized depressions, a web was prepared as in Example 7 using the transfer roll described in Example

3. The basis weight of each transferred molten polymer region was 292 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 37 grams/m^2. The temperature of the backup roll was approximately 93^{O}C and the temperature of the forming roll was approximately 38^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 330 microns.

Example 10

To demonstrate the use of a transfer roll having larger sized depressions, a web was prepared as in Example 1 except the exterior surface of the transfer roll was machined using a computer controlled milling machine to have elongated hemispherical depressions 5.1 mm in diameter and 5.1 mm in depth, having a volume of 34.3 mm^3 and an area of 6.5 mm^2 arranged in a staggered array with center-to-center spacing between depressions of 8.5 mm resulting in 1.4 depressions/cm^2 across the exterior surface of the transfer roll. A linear low density polyethylene (ASPUN 6806, 100 MI, Dow Chemical) pigmented with 2% of a red polyolefin-based color concentrate (1053237, Clariant Corp.), was used at a melt temperature of approximately 190^{O}C. The temperature of the transfer roll was approximately 198^{O}C. A polyester spunlaced nonwoven (SONTARA 8005, 68 grams/m^2, Dupont) was used for a substrate. A nip pressure of 131 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 175 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll consisted of a silicone rubber sleeve on a steel roll containing cavities with diameters of about 0.13 mm, depths of about 1.2 mm and spacing of about 0.83 mm, resulting in about 248 cavities/cm^2. The cavities were 90 degrees from the tangent of the roll surface. The basis weight of each transferred molten polymer region was 945 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 85 grams/m^2. The temperature of the backup roll was approximately 93^{O}C and the temperature of the forming roll was approximately 49^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 457 microns.

Example 11

To demonstrate the use of a different polymer and forming, a web was prepared as in Example 10 except a blend of KRATON 1117D SIS block copolymer (90%, Shell Chemical) with ASPUN 6806 polyethylene (10%, Dow Chemical) was used at a melt temperature of approximately 207°C. The temperature of the transfer roll was approximately 207°C. A nip pressure of 131 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 263 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll consisted of a silicone rubber sleeve on a steel roll containing cavities with diameters of about 0.1 mm, depths of about 1.0 mm and spacing of about 0.5 mm, resulting in about 388 cavities/cm^2. The cavities were 90 degrees from the tangent of the roll surface. The basis weight of each transferred molten polymer region was 1302 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 117 grams/m^2. The temperature of the backup roll was approximately 93°C and the temperature of the forming roll was approximately 49°C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 305 microns.

Example 12

To demonstrate the use of a different polymer and forming roll, a web was prepared as in Example 10 except ASPUN 6806 polyethylene was used at a melt temperature of approximately 190°C.The temperature of the transfer roll was approximately 190°C. A nip pressure of 175 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 263 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll described in Example 1 was used. The basis weight of each transferred molten polymer region was 1240 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 112 grams/m^2. The temperature of the backup roll was approximately 104^{O}C and the temperature of the forming roll was approximately 66^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 533 microns.

Example 13

To demonstrate the use of a different polymer and forming roll, a web was prepared as in Example 10 except PS164-400 polyurethane was used at a melt temperature of approximately 201^{O}C. The temperature of the transfer roll was approximately 218^{O}C. A nip pressure of 131 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 44 N/lineal cm, formed by a rubber backup roll and a forming roll. A forming roll similar to that described in Example 1 was used except the cavities were angled at 45 degrees from the tangent of the roll surface in alternating directions with half of the cavities angled to the left in the cross direction, and half of the cavities angled to the right in the cross direction, each of the cavities in a given row, angled in the same direction, with the cavities in the adjacent row angled in the opposite direction. The basis weight of each transferred molten polymer region was 1147 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 103 grams/m^2. The temperature of the backup roll was approximately 93^{O}C and the temperature of the forming roll was approximately 49^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 343 microns.

Example 14

To demonstrate the use of a different polymer a web was prepared as in Example 13 except ESTANE 58238 (Noveon) polyurethane was used at a melt temperature of approximately 190^{O}C.The temperature of the transfer roll was approximately 218^{O}C. A nip pressure of 219 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. The basis weight of each transferred molten polymer region was 1286 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 116 grams/m^2. The temperature of the backup roll was approximately 93^{O}C and the temperature of the forming roll was approximately 49^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 259 microns.

Example 15

To demonstrate the use of a different polymer and forming roll, a web was prepared as in Example 12 except a nip pressure of 219 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 44 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll described in Example 11 was used. The basis weight of each transferred molten polymer region was 1069 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 96 grams/m^2. The temperature of the backup roll was approximately 93^{O}C and the temperature of the forming roll was approximately 49^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 272 microns.

Example 16

To demonstrate the use of a different polymer, a web was prepared as in Example 15 except ENGAGE 8402 polyethylene was used at melt temperature of approximately 190^{O}C. The temperature of the transfer roll was approximately 218^{O}C. A nip pressure of 131 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 44 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll described in Example 11 was used. The basis weight of each transferred molten polymer region was 821 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 74 grams/m^2. The temperature of the backup roll was approximately 93°C and the temperature of the forming roll was approximately 49°C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 269 microns.

Example 17

To demonstrate the use of a different transfer roll, a web was prepared as in Example 16 except the exterior surface of the transfer roll was machined using a computer controlled milling machine to have hemispherical depressions 2.3 mm in diameter and 1.3 mm in depth, having a volume of 3.6 mm^3 and an area of 4.1 mm^2 arranged in a staggered array with center-to-center spacing between depressions of 5.1 mm resulting in 3.9 depressions/cm^2 across the exterior surface of the transfer roll. The temperature of the transfer roll was approximately 218°C. The doctor blade pressure was 219 N/lineal cm. A nip pressure of 131 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 88 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll described in Example 11 was used. The basis weight of each transferred molten polymer region was 207 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 33 grams/m^2. The temperature of the backup roll was approximately 85°C and the temperature of the forming roll was approximately 33°C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 432 microns.

Example 18

To demonstrate the use of a different polymer, and an additional processing step, a web was prepared as in Example 17 except ASPUN 6806 polyethylene was used at melt temperature of approximately 218°C. The temperature of the transfer roll was approximately 218°C. The doctor blade pressure was 219 N/lineal cm. A nip pressure of 131 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. A polyester spunlaced nonwoven (140-070, 34 grams/m^2, BBA-Veratec) was used as a substrate. The forming roll described in Example 11 was used. The basis weight of each transferred molten polymer region was 154 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 24 grams/m^2. The temperature of the backup roll was approximately 85^{O}C and the temperature of the forming roll was approximately 58^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 495 microns. The distal ends of the stems on the web were then subsequently capped using a similar method as taught in commonly assigned U.S. Patent No. 6,132,660 (Kampfer). The web was fed through a nip formed by two calendar rolls. The temperature of the top roll which contacted the ends of the stems to form "caps" was approximately 103^{O}C. The temperature of the bottom roll was approximately 60^{O}C. The gap between the two rolls was set at 584 microns. The "capped" web was then fed into a heated rubber nip consisting of a heated top roll (73^{O}C) and a tap water-fed bottom roll, at a pressure of 750 N, to further deform the caps.

Example 19

To demonstrate the use of a different polymer, a web was prepared as in Example 17 except ESTANE 58238 polyurethane was used at a melt temperature of approximately 201^{O}C. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 44 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll described in Example 11 was used. The basis weight of each transferred molten polymer region was 292 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 47 grams/m^2. The temperature of the backup roll was approximately 85^{O}C and the temperature of the forming roll was approximately 41^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 269 microns.

Example 20

A web was produced as in Example 17 except two different polymers were used and delivered to three separate regions on the transfer roll. The trough described in Example 1 was constructed with two dividers between the side walls so as to have three separate smaller troughs arranged in an A-B-A configuration across the transfer roll, that could receive three separate molten polymer streams. KRATON 1657 was delivered to the 'A' troughs using the extruder described in Example 1 at a melt temperature of approximately 218°C. Polyethylene (ASPUN 6806, Dow Chemical) was delivered by a J&M Grid Melter and heated pipe to the 'B' trough at a melt temperature of approximately 218°C. The transfer roll described in Example 17 was used at a temperature of approximately 232°C. A nip pressure of 263 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 53 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll described in Example 11 was used. The basis weight of each transferred molten polymer 'A' region was 171 grams/m^2. The cumulative basis weight of the transferred polymer 'A' regions on the nonwoven substrate was 26 grams/m^2. The basis weight of each transferred molten polymer 'B' region was 219 grams/m^2. The cumulative basis weight of the transferred polymer 'B' regions on the nonwoven substrate was 35 grams/m^2. The height of the stems produced by the forming roll in the 'A' region, measured normal to the surface of the base polymer region, was 170 microns. The temperature of the backup roll was approximately 85°C and the temperature of the forming roll was approximately 43°C. The height of the stems produced by the forming roll in the 'B' region, measured normal to the surface of the base polymer region, was 508 microns.

Example 21

To demonstrate the use of a different polymer, and an additional processing step, a web was prepared as in Example 18 except H2104 polyethylene (Huntsman Chemical) was used at melt temperature of approximately 212°C. The transfer roll described in Example 10 was used. The temperature of the transfer roll was approximately 204°C. The doctor blade pressure was 131 N/lineal cm. A nip pressure of 175 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. A polyester spunlaced nonwoven (SONTARA 8005, 68 grams/m^2, Dupont) was used as a substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 53 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll described in Example 11 was used. The basis weight of each transferred molten polymer region was 1023 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 92 grams/m^2. The temperature of the backup roll was approximately 77°C and the temperature of the forming roll was approximately 71°C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 394 microns. The distal ends of the stems on the web were then subsequently capped using the same equipment and conditions as described in Example 18.

Example 22

To demonstrate the use of a different transfer roll, a web was prepared as in Example 15 except the exterior surface of the transfer roll was machined using a computer controlled milling machine to have depressions in the shape of grooves parallel to the roll axis 20 cm long, 2.3 mm in width, 1.3 mm in depth, having a volume of about 600 mm^3 and an area of 581 mm^2 arranged with a center-to-center spacing between grooves of 1.0 cm. The temperature of the transfer roll was approximately 176°C. ASPUN 6806 polyethylene was used at a melt temperature of approximately 176°C. The doctor blade pressure was 88 N/lineal cm. A nip pressure of 350 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 44 N/lineal cm, formed by a rubber backup roll and a forming roll. The forming roll described in Example 11 was used. The basis weight of each transferred molten polymer region was 36 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 98 grams/m^2. The temperature of the backup roll was approximately 77°C and the temperature of the forming roll was approximately 71°C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 414 microns.

Example 23

To demonstrate the use of a different polymer, a web was prepared as in Example 22 except polyethylenevinylacetate (ELVAX 150, Dupont) was used at melt temperature of approximately 176°C. A nip pressure of 88 N/lineal cm was used to transfer some of the molten polymer from the depressions to the nonwoven substrate. The basis weight of each transferred molten polymer region was 43 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 117 grams/m^2. The temperature of the backup roll was approximately 77°C and the temperature of the forming roll was approximately 71°C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 350 microns.

Example 24

To demonstrate that the webs of the invention can be laminated to additional substrates, a web was prepared as in Example 18 above. The web was then laminated to an elastic composite web using a Bostik 9041 hot melt adhesive using the procedure described in Example 4 of PCT Publication WO 00/20200. The elastic composite web was a 280 denier GLOSPAN elastic filaments (2.75 filaments/cm, stretch ratio of 2.5:1) positioned on top of a polypropylene spunbond nonwoven (15 grams/m^2, PGI Nonwovens).

Comparative Example C1

To compare the process of the present invention with the well known process of rotary screen printing, a web was prepared using the following materials, equipment and conditions. A 2.5 cm diameter single screw extruder was used to deliver molten polyurethane (ESTANE 58238) at a melt temperature of approximately 218°C to a slot die having a 0.5 mm gap. The curtain of molten polymer was extruded vertically downward onto the interior surface of a metal screen roll (201°C) having a thickness of 0.4 mm and a diameter of 25 cm.

The screen roll was formed to have circular apertures 2.3 mm in diameter, arranged in a staggered array with center-to-center spacing between apertures of 5.1 mm resulting in 3.9 depressions/cm^2. A doctor blade attached to the die tip contacted the interior surface of the screen roll at a pressure of 35 N/lineal cm. The doctor blade forced molten polymer through the apertures in the screen and wiped most of the excess molten polymer from the interior surface of the screen. After the wiping action of the doctor blade, the screen roll continued to rotate until the apertures and the molten polymer they contain were forced into contact with a polyester spunlaced nonwoven substrate (SONTARA 8005, 68 gram/m^2, Dupont) against a steel impression roll (36^{O}C) using a nip pressure of 18 N/lineal cm. Transfer of some of the molten polymer from the apertures to the nonwoven substrate occurred. A portion of the molten polymer in the apertures remained in the apertures while the substrate pulled away from the screen roll. As a result, the molten polymer tended to elongate or string between the apertures in the screen roll and the substrate. A hot wire was used to sever any strands of molten polymer formed as the substrate separated from the screen roll. The basis weight of each transferred molten polymer region was 171 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 27 grams/m^2. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 438 N/lineal cm formed by a rubber backup roll and the forming roll described in Example 1. The temperature of the forming roll was approximately 41^{O}C. The height of the stems produced by the forming roll, measured normal to the surface of the base polymer region, was 190 microns. The height of the stems produced by the rotary screen process was significantly lower than the heights of the stems produced by the process of the invention.

Comparative Example C2

To further compare the process of the present invention with the well known process of rotary screen printing, a web was prepared as in Comparative Example C1 using KRATON 1657 SEBS block copolymer (Shell Chemical) pigmented with a polyolefin-based black color concentrate (CCC-294,1%, Polymer Color) at a melt temperature of approximately 218^{O}C. The temperature of the screen roll was approximately 190^{o}C. The basis weight of each transferred molten polymer region was 97 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 16 grams/m^2. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 438 N/lineal cm formed by a rubber backup roll and the forming roll described in Example 11. The temperature of the forming roll was approximately 41^{o}C. The amount of polymer transferred to the substrate was insufficient to allow for the formation of stems using the rotary screen process even at very high nip pressures.

Comparative Example C3

To further compare the process of the present invention with the well known process of rotary screen printing, a web was prepared as in Comparative Example C1 using ASPUN 6806 polyethylene at a melt temperature of approximately 207^{o}C. A grid melter was used to deliver the molten polymer to the interior surface of the screen roll. The screen roll was formed to have circular apertures 1.8 mm in diameter, arranged in a staggered array with center-to-center spacing between apertures of 6.4 mm resulting in 2.5 depressions/cm^2. The temperature of the screen roll was approximately 190^{o}C. The nonwoven substrate described in Example 1 was used. The basis weight of each transferred molten polymer region was 49 grams/m^2. The cumulative basis weight of the transferred polymer regions on the nonwoven substrate was 5 grams/m^2. After transfer of the molten polymer to the substrate, the substrate was driven through a nip at a pressure of 438 N/lineal cm formed by a rubber backup roll and the forming roll described in Example 11. The temperature of the forming roll was approximately 41^{o}C. The amount of polymer transferred to the substrate was insufficient to allow for the formation of stems using the rotary screen process even at very high nip pressures.

The preceding specific embodiments are illustrative of the practice of the invention. This invention may be suitably practiced in the absence of any element or item not specifically described in this document. The complete disclosures of all patents, patent applications, and publications are incorporated into this document by reference as if individually incorporated. Various modifications and alterations of this invention will become apparent to those skilled in the art without departing from the scope of this invention. It should be understood that this invention is not to be unduly limited to illustrative embodiments set forth herein.

CLAIMS:

1. A method for producing a composite web, the method comprising:

providing a transfer roll comprising an exterior surface that comprises one or more depressions formed therein;

delivering a molten thermoplastic composition onto the exterior surface of the transfer roll;

wiping the molten thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten thermoplastic composition from the exterior surface of the transfer roll;

transferring at least a portion of the molten thermoplastic composition in the one or more depressions to a first major surface of a substrate by contacting the first surface of the substrate to the exterior surface of the transfer roll and the molten thermoplastic composition in the one or more depressions, followed by separating the substrate from the transfer roll, wherein one or more discrete polymeric regions comprising the thermoplastic composition are located on the first major surface of the substrate after separating the substrate from the transfer roll;

contacting the one or more discrete polymeric regions on the substrate with a forming tool under pressure, wherein a portion of the thermoplastic composition in at least one discrete polymeric region of the one or more discrete polymeric regions contacting the forming tool enters a plurality of cavities in the forming tool; and

separating the substrate and the one or more discrete polymeric regions from the forming tool, wherein the at least one discrete polymeric region comprises a plurality of structures formed thereon, after separating the one or more discrete polymeric regions from the forming tool, the plurality of structures corresponding to the plurality of cavities in the forming tool.

2. A method according to claim 1, wherein the transferring further comprises forcing the first major surface of the substrate against the exterior surface of the transfer roll and the molten thermoplastic composition in the one or more depressions.

3. A method according to claim 1, wherein the first major surface of the substrate comprises a porous surface, and wherein the transferring further comprises forcing a portion of the first major surface of the substrate into the one or more depressions, wherein a portion of the thermoplastic composition in the one or more depressions infiltrates the porous surface within the one or more depressions.

4. A method according to claim 3, wherein the porous surface of the substrate comprises fibers, and further wherein the transferring further comprises encapsulating at least a portion of at least some of the fibers in the molten thermoplastic composition.

5. A method according to claim 1, wherein the first major surface of the substrate comprises fibers, and further wherein the transferring further comprises encapsulating at least a portion of at least some of the fibers in the molten thermoplastic composition by forcing the first major surface of the substrate against the exterior surface of the transfer roll and the molten thermoplastic composition in the one or more depressions.

6. A method according to claim 1, wherein substantially all of the one or more depressions are substantially filled with the molten thermoplastic composition after the wiping and before the transferring.

7. A method according to claim 1, wherein each depression of the one or more depressions defines a depression volume, and further wherein the one or more depressions comprises at least two depressions that define different depression volumes.

8. A method according to claim 1, wherein at least one discrete polymeric region of the one or more discrete polymeric regions comprises a shape extending continuously along a length of the substrate.

9. A method according to claim 1, wherein at least one discrete polymeric region of the one or more discrete polymeric regions comprises a shape extending continuously across a width of the substrate.

10. A method according to claim 1, wherein the one or more depressions comprise a plurality of depressions comprising depressions having at least two different shapes.

11. A method according to claim 1, wherein each depression of the one or more depressions comprise a depression volume of about 3 cubic millimeters or more.

12. A method according to claim 1, wherein the footprint of each depression of the one or more depressions comprises an area of about 4 square millimeters or more.

13. A method according to claim 1, wherein the plurality of structures formed on the at least one discrete polymeric region comprise stems.

14. A method according to claim 13, wherein the stems are oriented substantially perpendicular to the substrate.

15. A method according to claim 13, wherein the stems are oriented at an acute angle to the substrate.

16. A method according to claim 1, wherein the plurality of structures formed on the at least one discrete polymeric region comprise hooks.

17. A method according to claim 1, wherein the plurality of structures formed on the at least one discrete polymeric region comprise pyramids.

18. A method according to claim 1, further comprising deforming the plurality of structures on the at least one discrete polymeric regions after separating the substrate and the one or more discrete polymeric regions from the forming tool.

19. A method according to claim 18, wherein deforming the plurality of structures comprises capping the plurality of structures.

20. A method for producing a composite web, the method comprising:

providing a transfer roll comprising an exterior surface that comprises one or more depressions formed therein;

delivering a molten thermoplastic composition onto the exterior surface of the transfer roll;

wiping the molten thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten thermoplastic composition enters the one or more depressions, and wherein the portion of the molten thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten thermoplastic composition from the exterior surface of the transfer roll, and substantially all of the one or more depressions are substantially filled with the molten thermoplastic composition after the wiping;

forcing a portion of a first major surface of a substrate into the one or more depressions, wherein the first major surface comprises a porous surface comprising fibers, and wherein a portion of the molten thermoplastic composition in the one or more depressions infiltrates the porous surface, and still further wherein the molten thermoplastic composition encapsulates at least a portion of at least some of the fibers;

separating the substrate from the transfer roll, wherein one or more discrete polymeric regions comprising the thermoplastic composition are located on the first major surface of the substrate after separating the substrate from the transfer roll;

contacting the one or more discrete polymeric regions on the substrate with a forming tool under pressure, wherein a portion of the thermoplastic composition in at least one discrete polymeric region of the one or more discrete polymeric regions contacting the forming tool enters a plurality of cavities in the forming tool; and

separating the substrate and the one or more discrete polymeric regions from the forming tool, wherein the at least one discrete polymeric region comprises a plurality of structures formed thereon after separating the one or more discrete polymeric regions from the forming tool, the plurality of structures corresponding to the plurality of cavities in the forming tool.

21. A method according to claim 20, wherein each depression of the one or more depressions defines a depression volume, and further wherein the one or more depressions comprises at least two depressions that define different depression volumes.

22. A method according to claim 20, wherein at least one discrete polymeric region of the one or more discrete polymeric regions comprises a shape extending continuously along a length of the substrate.

23. A method according to claim 20, wherein at least one discrete polymeric region of the one or more discrete polymeric regions comprises a shape extending continuously across a width of the substrate.

24. A method according to claim 20, wherein the one or more depressions comprise a plurality of depressions comprising depressions having at least two different shapes.

25. A method according to claim 20, wherein each depression of the one or more depressions comprise a depression volume of about 3 cubic millimeters or more.

26. A method according to claim 20, wherein the footprint of each depression of the one or more depressions comprises an area of about 4 square millimeters or more.

27. A method according to claim 20, wherein the plurality of structures formed in the at least one discrete polymeric region comprise stems.

28. A method according to claim 27, wherein the stems are oriented substantially perpendicular to the substrate.

29. A method according to claim 27, wherein the stems are oriented at an acute angle to the substrate.

30. A method according to claim 20, wherein the plurality of structures formed in the at least one discrete polymeric region comprise hooks.

31. A method according to claim 20, wherein the plurality of structures formed in the at least one discrete polymeric region comprise pyramids.

32. A method according to claim 20, further comprising deforming the plurality of structures on the at least one discrete polymeric regions after separating the substrate and the one or more discrete polymeric regions from the forming tool.

33. A method according to claim 32, wherein deforming the plurality of structures comprises capping the plurality of structures.

34. A system for manufacturing composite webs, the system comprising:

a substrate defining a web path through the system, the web path comprising a downstream direction along which the substrate moves through the system;

a molten thermoplastic composition delivery apparatus;

a transfer roll located along the web path, the transfer roll comprising an exterior surface and one or more depressions formed in the exterior surface of the transfer roll, wherein a portion of the exterior surface of the transfer roll is in contact with a first major surface of the substrate, and wherein the transfer roll is positioned to receive molten thermoplastic composition from the molten thermoplastic delivery apparatus such that molten thermoplastic composition enters the one or more depressions;

a wiping apparatus in contact with the exterior surface of the transfer roll, the wiping apparatus positioned to remove molten thermoplastic composition from the exterior surface of the transfer roll before the molten thermoplastic composition on the exterior surface of the transfer roll contacts the substrate;

a transfer nip along the web path, wherein the first major surface of the substrate is forced against the exterior surface of the transfer roll at the transfer nip, whereby at least a portion of the molten thermoplastic composition in the one or more depressions transfers to the first major surface of the substrate during operation of the system to form one or more discrete polymeric regions on the first major surface of the substrate; and

a forming nip located along the web path downstream from the transfer nip, wherein a forming tool is forced against the first major surface of the substrate and the one or more discrete polymeric regions in the forming nip, the forming tool comprising a plurality of cavities facing the first major surface of the substrate, the plurality of cavities forming a plurality of structures on the one or more discrete polymeric regions.

35. A system according to claim 34, wherein the transfer nip and the forming nip are located on the same backup roll.

36. A system according to claim 34, wherein the transfer nip comprises a conformable backup roll adapted to force a portion of the substrate into the one or more depressions on the transfer roll.

37. A system according to claim 34, wherein the transfer nip comprises a mating backup roll comprising protrusions adapted to force a portion of the substrate into the one or more depressions on the transfer roll.

38. A system according to claim 34, wherein each depression of the one or more depressions in the exterior surface of the transfer roll defines a depression volume, and further wherein the one or more depressions comprises at least two depressions that define different depression volumes.

39. A system according to claim 34, wherein at least one depression of the one or more depressions comprises a shape extending continuously about a circumference of the transfer roll.

40. A system according to claim 34, wherein the one or more depressions comprise a plurality of depressions comprising depressions having at least two different shapes.

41. A system according to claim 34, further comprising a deforming station located along the web path downstream from the forming nip, the deforming station comprising equipment adapted to deform the plurality of structures on the one or more discrete polymeric regions.

42. A system according to claim 41, wherein the deforming station comprises capping apparatus.

Docket No. 56502US002

SYSTEMS AND METHODS FOR COMPOSITE WEBS WITH STRUCTURED DISCRETE POLYMERIC REGIONS

ABSTRACT OF THE DISCLOSURE

Systems and methods for manufacturing composite webs including a substrate with one or more discrete polymeric regions located thereon are disclosed. The discrete polymeric regions are deposited by transferring molten thermoplastic composition from depressions on a transfer roll to a substrate. Each of the discrete polymeric regions is further formed to include multiple structures formed thereon. Those structures may include, for example, stems (capped or otherwise), hooks (as part of a hook and loop fastening system), pyramids, etc.

"EXPRESS MAIL" MAILING LABEL NUMBER EL888 271 342 US

DATE OF DEPOSIT November 5, 2001

I HEREBY CERTIFY THAT THIS PAPER OR FEE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE "EXPRESS MAIL POST OFFICE TO ADDRESSEE" SERVICE UNDER 37 CFR 1.10 ON THE DATE INDICATED ABOVE AND IS ADDRESSED TO THE ASSISTANT COMMISSIONER FOR PATENTS, Attn: Box Patent Application, WASHINGTON, D.C. 20231

PRINTED NAME Rachel Gagliardi-Graber

SIGNATURE [signature]

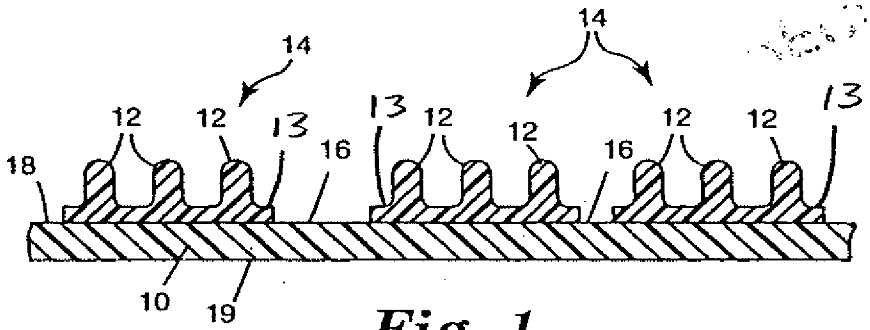


Fig. 1

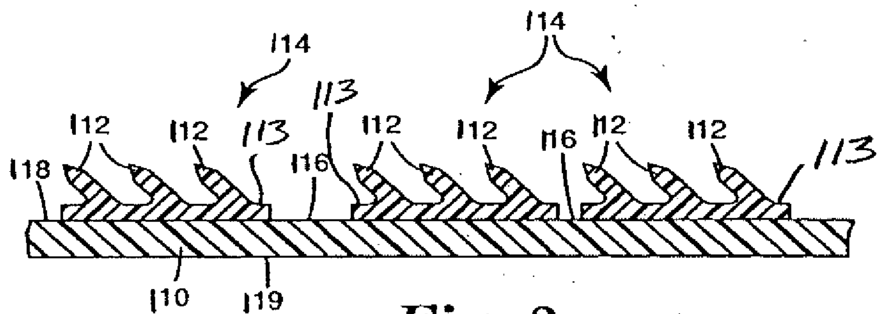


Fig. 2

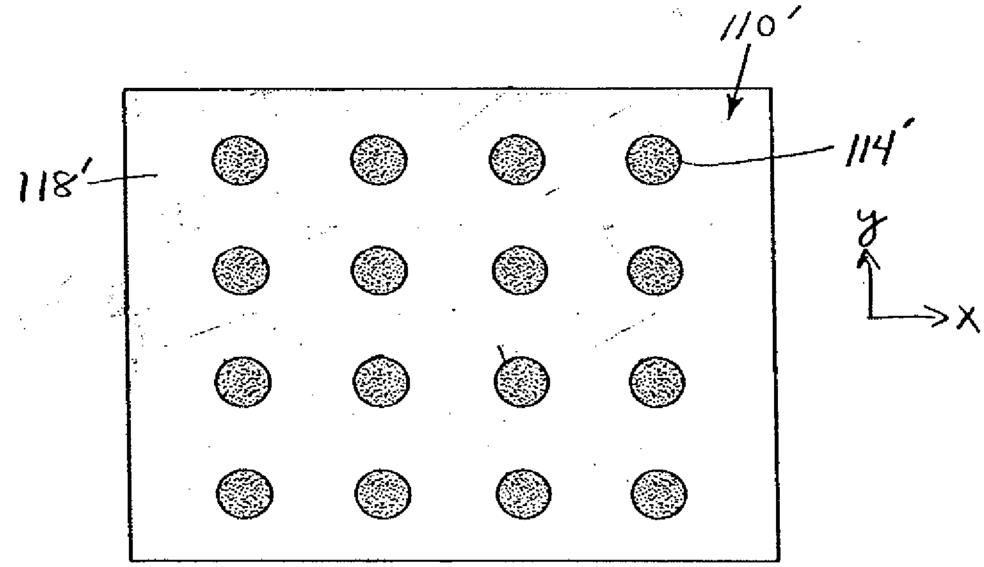


Fig. 3

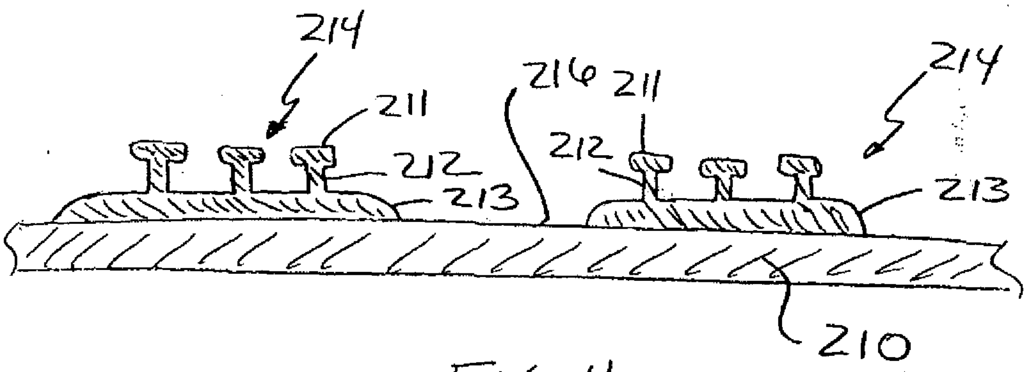


FIG. 4

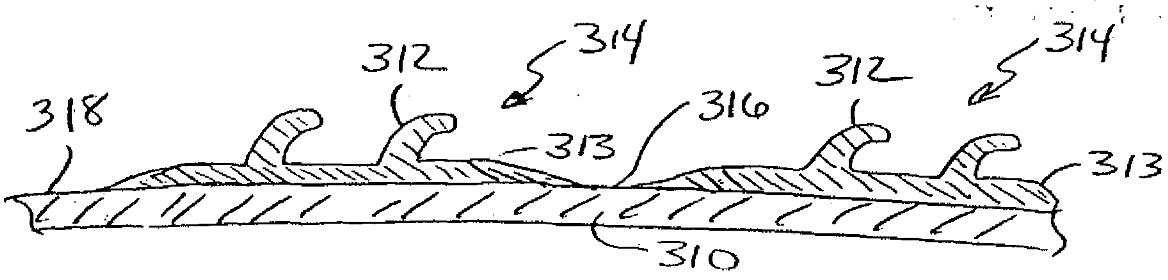


FIG. 5

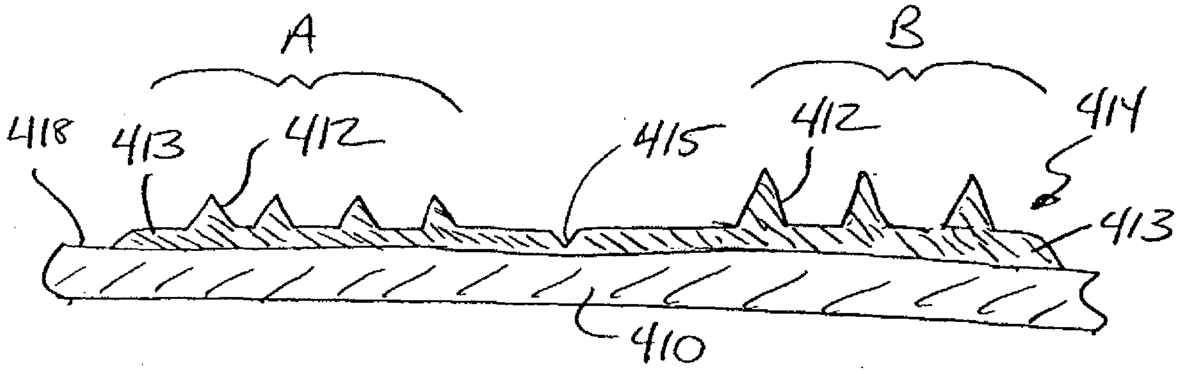


FIG. 6

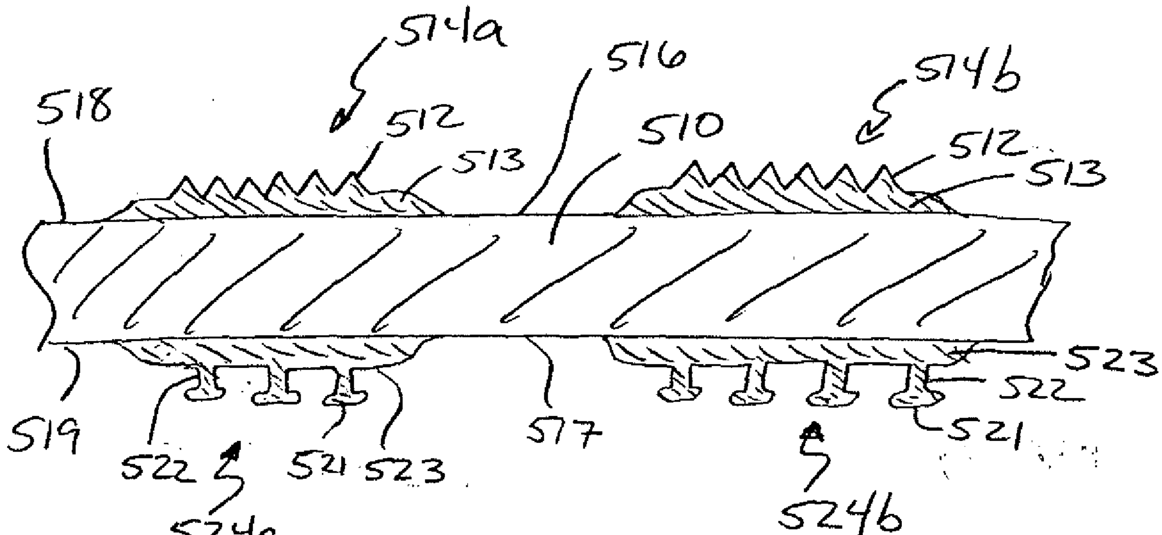

514a
516
514b
518
512
510
513
512
513
523
522
519
522
521
523
517
521
524a
524b

FIG 7

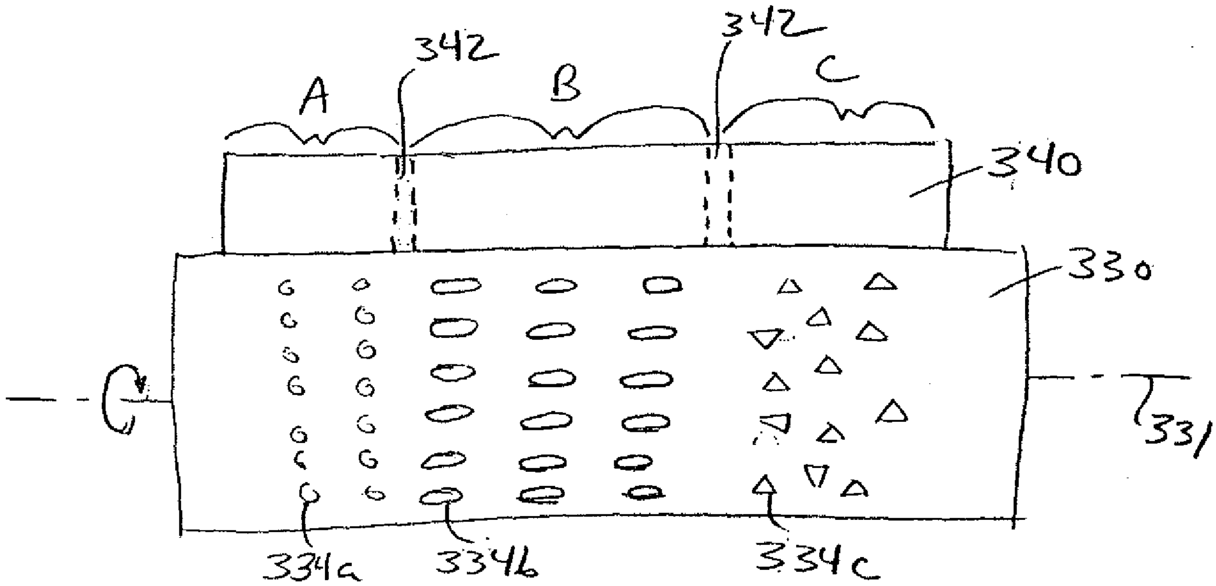

342
342
A
B
C
340
330
331
334a
334b
334c

FIG. 9

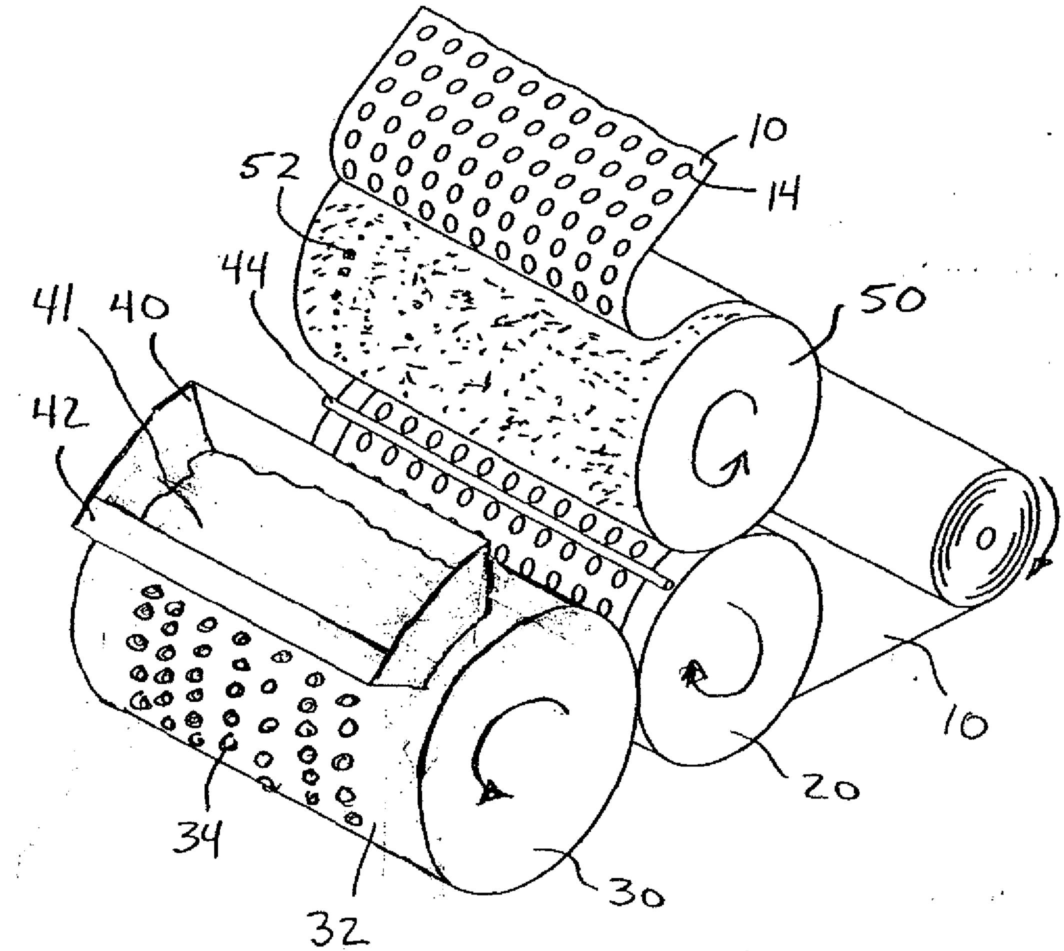


FIG. 8

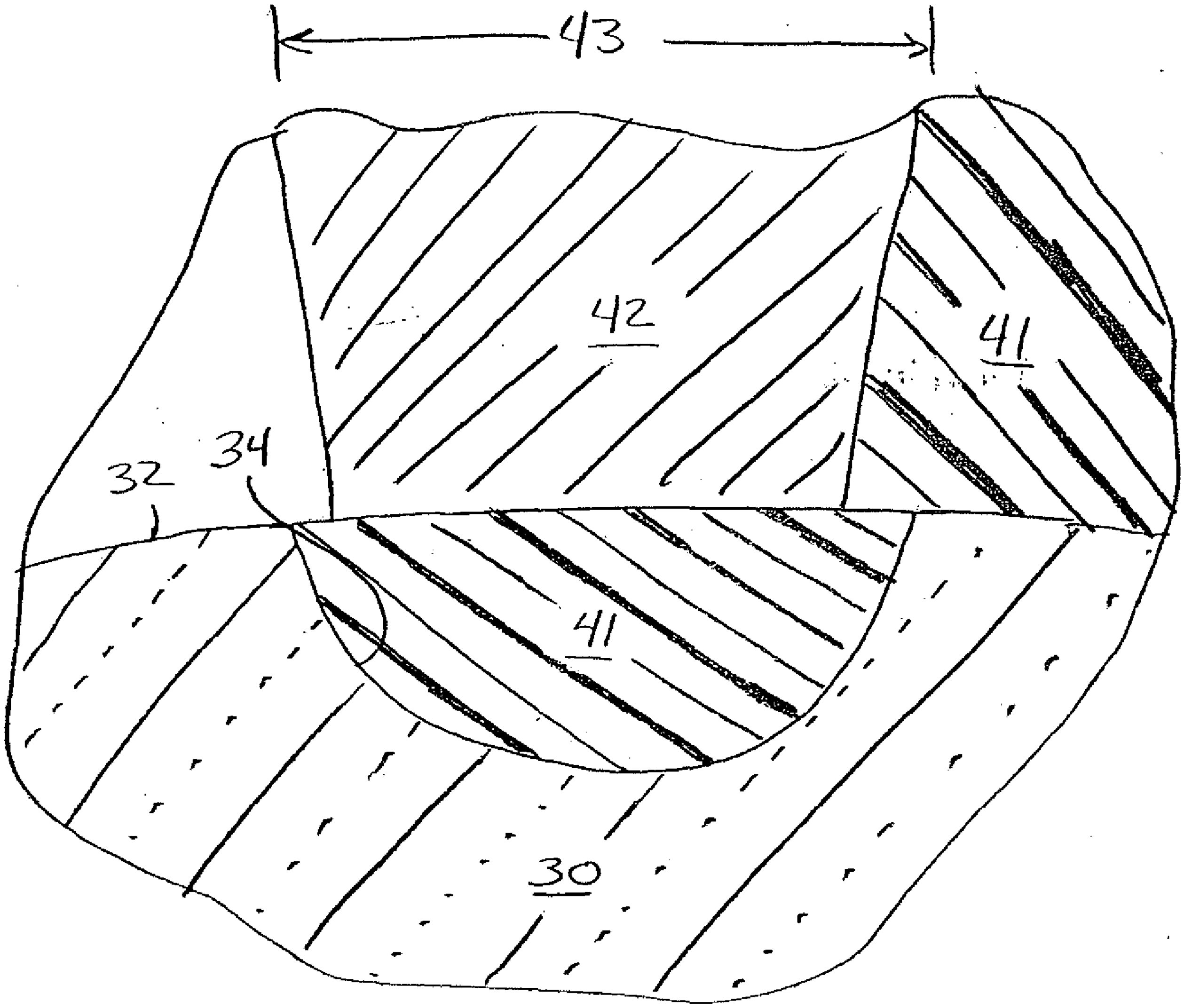


FIG. 8A

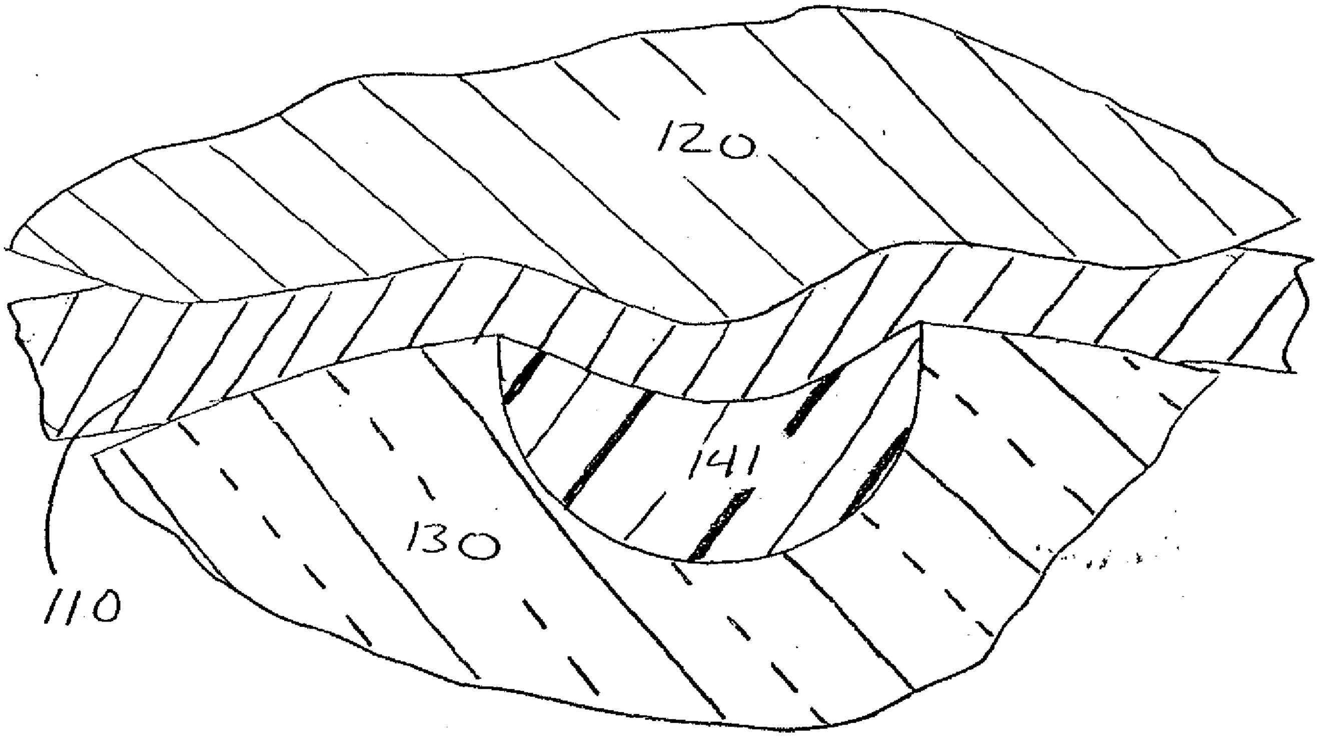


FIG. 8B

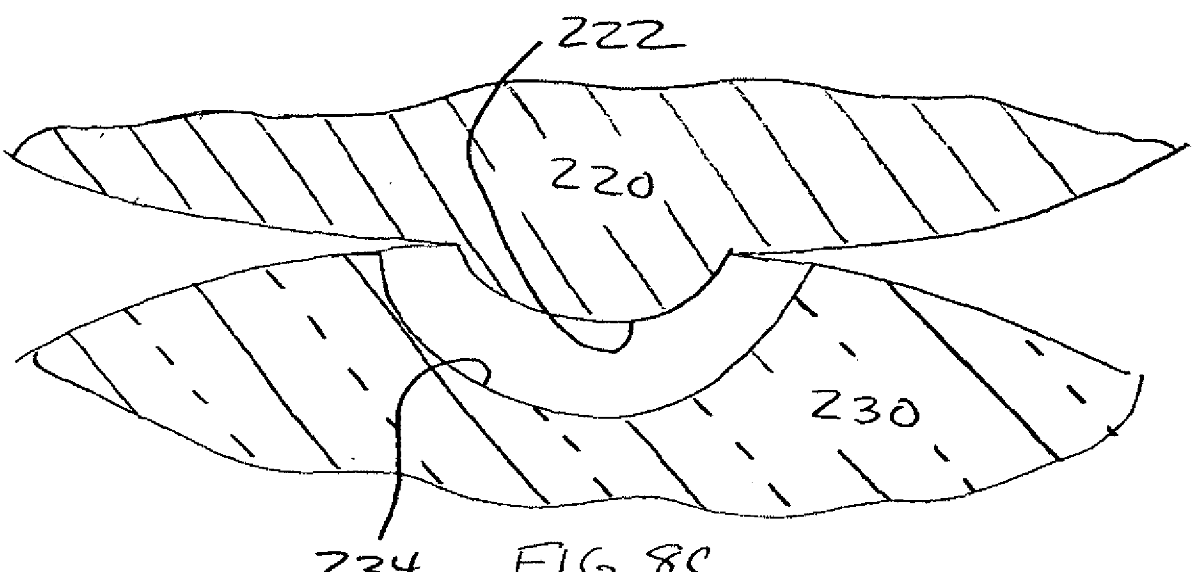


FIG. 8C

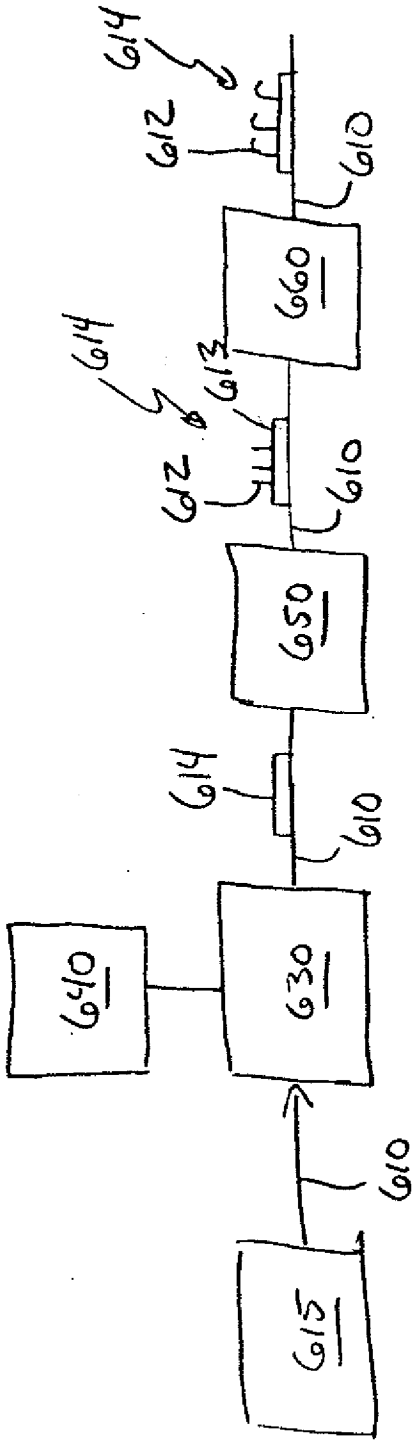


FIG. 8D

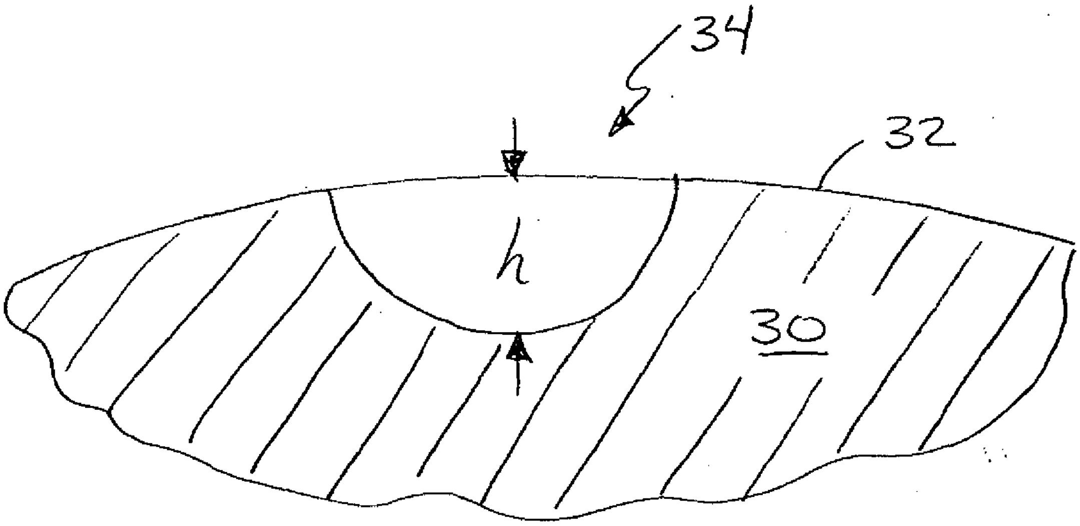


FIG. 11

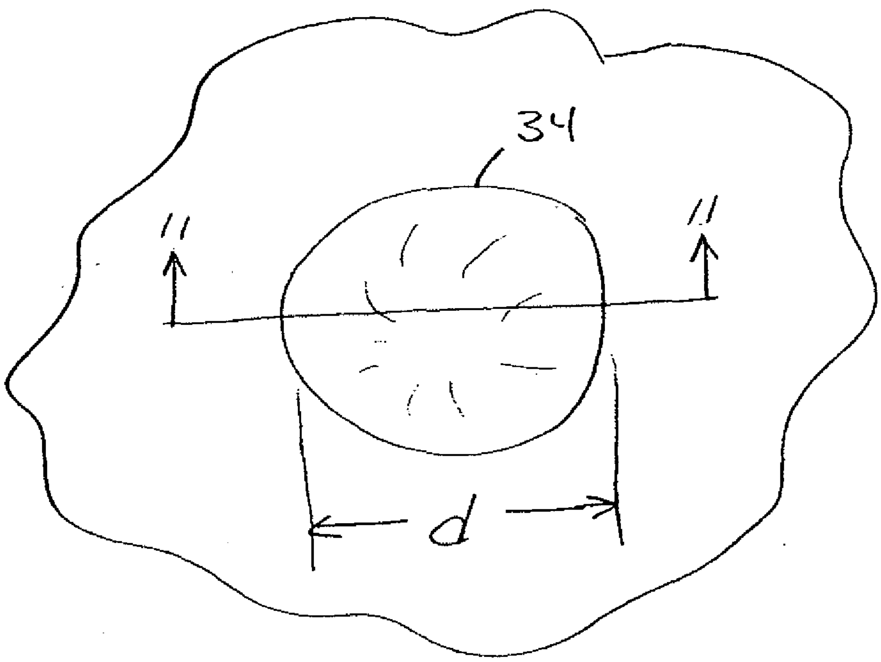


FIG. 10

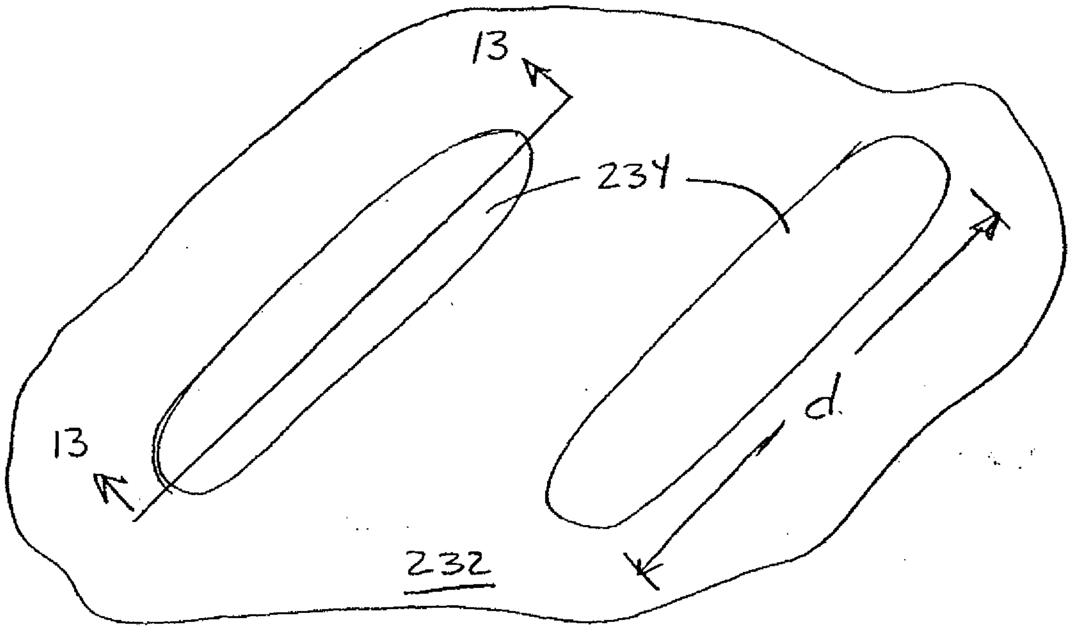


FIG. 12

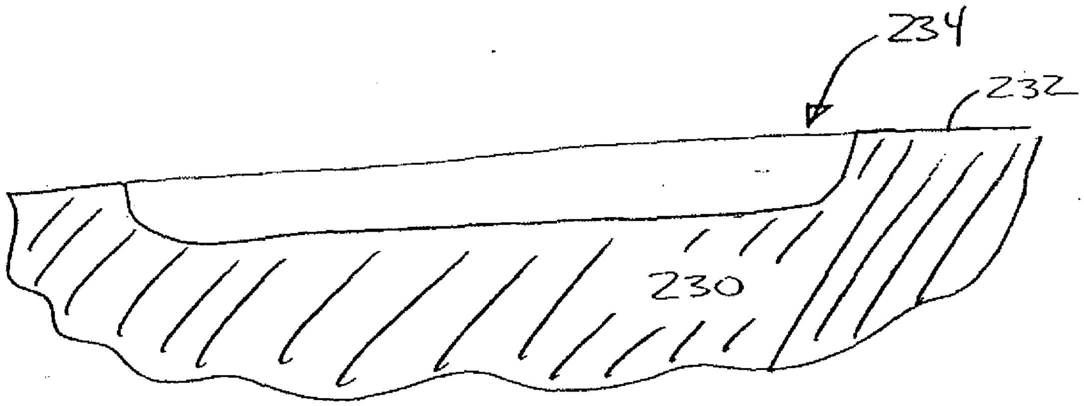


FIG. 13

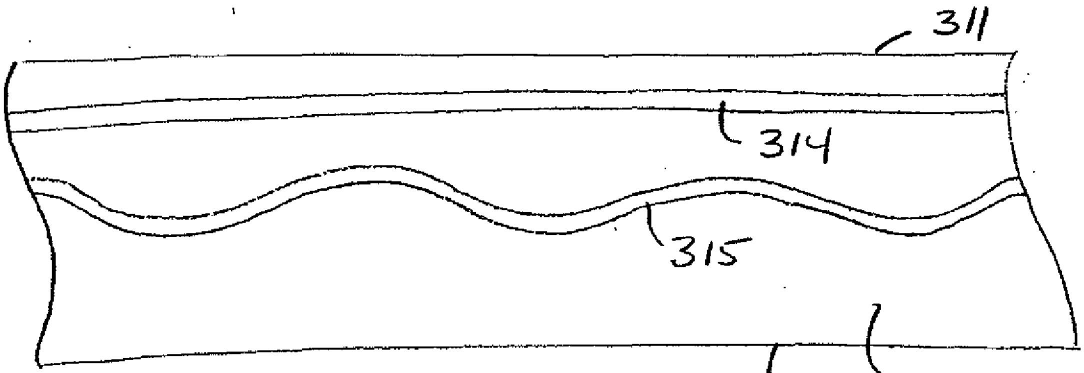


FIG. 14

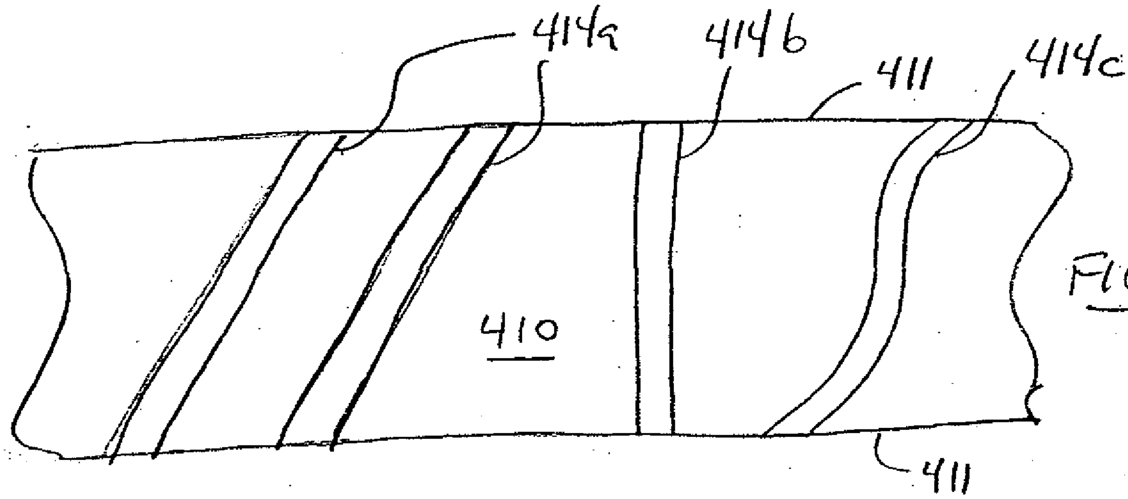


FIG. 16

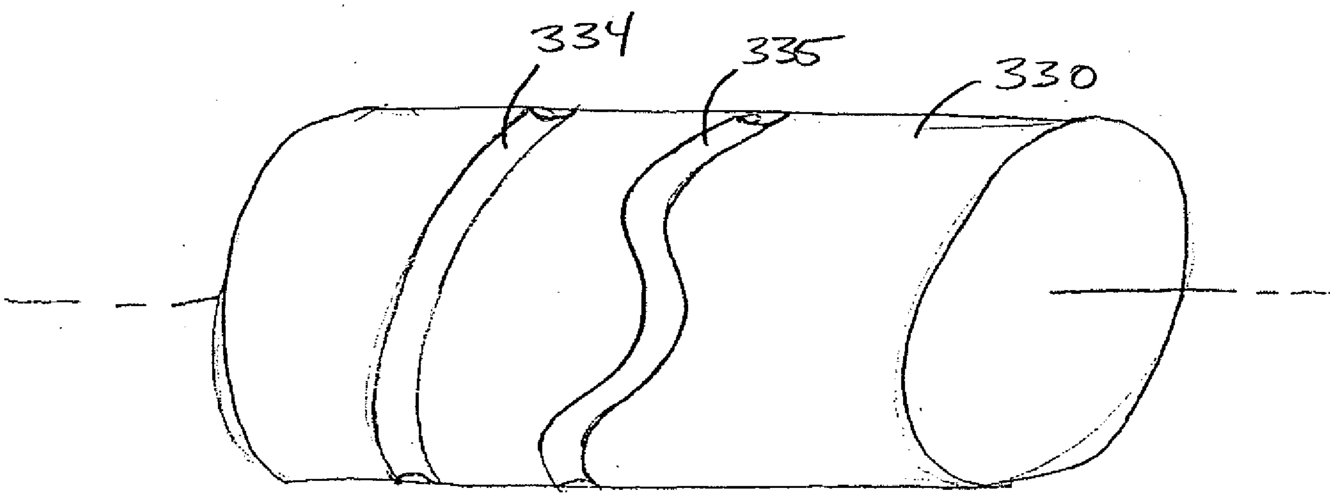


FIG. 15

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
10/012,900	11/05/2001	1772	0.00	57191US002	10	38	5

CONFIRMATION NO. 1318

26813
MUETING, RAASCH & GEBHARDT, P.A.
P.O. BOX 581415
MINNEAPOLIS, MN 55458

FILING RECEIPT

OC000000007354505

Date Mailed: 01/24/2002

Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Customer Service Center. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).**

Applicant(s)

Domestic Priority data as claimed by applicant

Foreign Applications

If Required, Foreign Filing License Granted 01/24/2002

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Title

Methods for producing composite webs with reinforcing discrete polymeric regions

Preliminary Class

428

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184

PATENT
Docket No. 57191US002

METHODS FOR PRODUCING COMPOSITE WEBS WITH REINFORCING DISCRETE POLYMERIC REGIONS

FIELD OF THE INVENTION

The present invention relates to methods of manufacturing composite webs that include reinforcing discrete polymeric regions.

BACKGROUND

The manufacture of articles formed of webs that require some reinforcement to withstand forces experienced during use are known. In many cases, reinforcement is simply provided over the entire substrate or web. Such approaches can, however, add cost and weight to the web, as well as stiffness over the entire surface of the web - even in those areas that do not require reinforcement. Furthermore, reinforcing layers that are coextensive with the web may also reduce its breathability.

To address some of these issues, smaller pieces of reinforcing materials may be attached to a web or substrate in selected areas that require reinforcement. The handling and attachment of such discrete pieces can, however, be problematic, by potentially reducing throughput, causing waste (where the discrete pieces are not securely attached), requiring precise registration or location on the web, requiring the use of adhesives or other bonding agents, etc. The discrete pieces may also present relatively sharp that may be the source of irritation or discomfort. The irritation or discomfort can be exacerbated because the reinforcing pieces are typically located on the surface of the substrate.

SUMMARY OF THE INVENTION

The present invention provides methods of manufacturing composite webs including a substrate with one or more reinforcing discrete polymeric regions located on or within the composite web.

One advantage of the methods of the present invention is the ability to transfer one or more discrete polymeric regions onto a major surface of a substrate, where the thermoplastic material of the discrete polymeric region can be forced against the substrate by a transfer roll. If the substrate is porous, fibrous, etc., pressure may enhance attachment of the discrete polymeric regions to the substrates by forcing a portion of the thermoplastic composition to infiltrate the substrate and/or encapsulate fibers of the substrate.

Another advantage is the ability to control the shape, spacing, and volume of the discrete polymeric regions. This may be particularly advantageous because these parameters (shape, spacing, and volume) can be fixed regardless of the line speed of the system.

Another advantage of the present invention may be found in the composite depressions and their use, which may improve the formation of reinforcing discrete polymeric regions in accordance with the present invention. The composite depressions may, e.g., improve the transfer of relatively large discrete polymeric regions onto the substrates as well as the transfer of discrete polymeric regions that have a varying thickness.

Another advantage of the methods of the present invention is the ability to provide one or more discrete polymeric regions that extend for the length of the substrate (while not being formed over the width of the substrate, i.e., the discrete polymeric regions are not coextensive with the major surface of the substrate).

Another advantage of the methods of the present invention is the ability to provide different thermoplastic compositions across the width of the substrate, such that some discrete polymeric regions may be formed of one thermoplastic composition, while other discrete polymeric regions are formed of a different thermoplastic composition.

Yet another advantage of the methods of the present invention is the ability to provide one or more discrete polymeric regions on both major surfaces of a substrate. The discrete polymeric regions on the opposing major surfaces may be formed with the same or different features as desired.

In one aspect, the present invention provides a method for producing a composite web, the method including providing a transfer roll having an exterior surface that includes one or more depressions formed therein, wherein the one or more depressions include at least one depression that includes a composite depression formed by a plurality of cells; and delivering a molten nonelastomeric thermoplastic composition onto the exterior surface of the transfer roll. The method further includes wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten nonelastomeric thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten nonelastomeric thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll; and transferring at least a portion of the molten nonelastomeric thermoplastic composition in the one or more depressions to a first major surface of a substrate by contacting the first major surface of the substrate to the exterior surface of the transfer roll and the molten nonelastomeric thermoplastic composition in the one or more depressions, followed by separating the substrate from the transfer roll, wherein one or more discrete polymeric regions formed of the nonelastomeric thermoplastic composition are located on the first major surface of the substrate after separating the substrate from the transfer roll.

In another aspect, the present invention provides a method for producing a composite web, the method including providing a transfer roll with an exterior surface that includes one or more depressions formed therein, wherein the one or more depressions include at least one depression that includes a composite depression formed by a plurality of overlapping cells; and delivering a molten nonelastomeric thermoplastic composition onto the exterior surface of the transfer roll. The method also includes wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten nonelastomeric thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten nonelastomeric thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll; and forcing a portion of a first major surface of a substrate into the one or more depressions, wherein the first major surface includes a porous surface including fibers, and wherein a portion of the nonelastomeric thermoplastic composition in the one or more depressions infiltrates the porous surface, and still further wherein the molten nonelastomeric thermoplastic composition encapsulates at least a portion of at least some of the fibers. The method further includes separating the substrate from the transfer roll, wherein one or more discrete polymeric regions formed of the nonelastomeric thermoplastic composition are located on the first major surface of the substrate after separating the substrate from the transfer roll.

In another aspect, the present invention provides a method for producing a composite web, the method including providing a transfer roll with an exterior surface that has one or more depressions formed therein; and delivering a molten nonelastomeric thermoplastic composition onto the exterior surface of the transfer roll. The method further includes wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten nonelastomeric thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten nonelastomeric thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll; and transferring at least a portion of the molten nonelastomeric thermoplastic composition in the one or more depressions to a first major surface of a first substrate by contacting the first major surface of the first substrate to the exterior surface of the transfer roll and the molten nonelastomeric thermoplastic composition in the one or more depressions, followed by separating the first substrate from the transfer roll, wherein one or more discrete polymeric regions formed of the nonelastomeric thermoplastic composition are located on the first major surface of the first substrate after separating the first substrate from the transfer roll. The method also includes laminating a second substrate to the first major surface of the first substrate, wherein the one or more discrete polymeric regions on the first substrate are located between the first substrate and the second substrate after laminating the second substrate to the first substrate.

In another aspect, the present invention provides a method for producing a composite web, the method including providing a transfer roll with an exterior surface that has one or more depressions formed therein; and delivering a molten nonelastomeric thermoplastic composition onto the exterior surface of the transfer roll. The method includes wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll, wherein a portion of the molten nonelastomeric thermoplastic composition enters the one or more depressions, and further wherein the portion of the molten nonelastomeric thermoplastic composition in the one or more depressions remains in the one or more depressions after wiping the molten nonelastomeric thermoplastic composition from the exterior surface of the transfer roll. The method also includes transferring at least a portion of the molten nonelastomeric thermoplastic composition in the one or more depressions to a first major surface of a first substrate by contacting the first major surface of the first substrate to the exterior surface of the transfer roll and the molten nonelastomeric thermoplastic composition in the one or more depressions, followed by separating the first substrate from the transfer roll, wherein one or more discrete polymeric regions formed of the nonelastomeric thermoplastic composition are located on the first major surface of the first substrate after separating the first substrate from the transfer roll. The method further includes laminating a second substrate to a second major surface of the first substrate, wherein the second major surface of the first substrate is located on the opposite side of the first substrate from the first major surface of the first substrate, wherein the one or more discrete polymeric regions on the first substrate are exposed on the first substrate.

In another aspect, the present invention provides a transfer roll device for transferring molten thermoplastic compositions to a substrate, the device including a roll with an exterior surface; and one or more depressions formed in the exterior surface of the roll, wherein each depression of the one or more depressions is a composite depression formed by a plurality of cells.

These and other features and advantages of methods according to the present invention are described below in connection with various illustrative embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of one reinforcing discrete polymeric region on a composite web manufactured according to the methods of the present invention.

FIG. 2 is a plan view of a portion of a transfer roll that can be used in manufacturing composite webs according to the methods of the present invention.

FIG. 3A is a cross-sectional view of the depression of FIG. 2, taken along line 3-3 in FIG. 2 at one point during formation of the depression.

FIG. 3B is a cross-sectional view of the depression of FIG. 2, taken along line 3-3 in FIG. 2 at another point during formation of the depression.

FIG. 3C is a cross-sectional view of the depression of FIG. 2, taken along line 3-3 in FIG. 2 during formation of the depression.

FIG. 4 is a plan view of another depression on a portion of a transfer roll that can used to manufacture reinforcing discrete polymeric regions on a composite web according to the methods of the present invention.

FIG. 5 is a cross-sectional view of the depression of FIG. 4, taken along line 5-5 in FIG. 4.

FIG. 6 is a plan view of another depression on a portion of a transfer roll that can used to manufacture reinforcing discrete polymeric regions on a composite web according to the methods of the present invention.

FIG. 7 is a cross-sectional view of a composite web manufactured according to the methods of the present invention including reinforcing discrete polymeric regions between two substrates.

FIG. 8 is a cross-sectional view of the composite web of FIG. 7, before attachment of the two substrates to form the composite web in accordance with the methods of the present invention.

FIG. 9 is a plan view of one illustrative substrate with reinforcing discrete polymeric regions formed thereon that can be manufactured into a composite web according to the methods of the present invention.

FIG. 10 is a cross-sectional view of another composite web with reinforcing discrete polymeric regions on both major surfaces of a substrate.

FIG. 11 is a perspective view of one polymer transfer process useful in providing discrete polymeric regions on a substrate in accordance with the methods of the present invention.

FIG. 11A is an enlarged schematic diagram depicting the relationship between a doctor blade and a depression on a transfer roll used in connection with the present invention.

FIG. 11B is an enlarged partial cross-sectional view depicting a conformable backup roll forcing a substrate against a transfer roll.

FIG. 11C is an enlarged partial cross-sectional view depicting a mating backup roll including protrusions aligned with depressions in the transfer roll.

FIG. 12 illustrates another transfer roll and polymer source useful in connection with zoned delivery systems and methods.

FIG. 13 is a plan view of one article formed in a composite web by providing reinforcing discrete polymeric regions on a substrate according to the methods of the present invention.

FIG. 14 is a cross-sectional view of the article of FIG. 13 taken along line 14-14 in FIG. 13.

FIG. 15 is a plan view of a portion of one composite web manufactured according to the present invention.

FIG. 16 is a perspective view of one transfer roll that may be used to manufacture the composite web of FIG. 15.

FIG. 17 is a plan view of a portion of one composite web manufactured according to the present invention that includes discrete polymeric regions extending across the width of the substrate.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS OF THE INVENTION

As discussed above, the present invention provides methods and systems for producing composite webs that include a substrate with reinforcing discrete polymeric regions located on the surface or within the composite web. Various different constructions will now be described to illustrate various embodiments of the composite webs that can be manufactured in accordance with the methods of the present invention. These illustrative constructions should not be considered to limit the methods of the present invention, which is to be limited only by the claims that follow.

FIG. 1 is a cross-sectional view of a portion of one composite web manufactured in accordance with the present invention. The composite web includes a substrate 10 with a first major surface 18 and a second major surface 19. One or more reinforcing discrete polymeric regions 14 are located on the first major surface 18 of the substrate 10, it being understood that the substrate may include more than one reinforcing discrete polymeric region as depicted in, e.g., FIGS. 7-12.

It may be preferred that the reinforcing discrete polymeric regions 14 of composite webs manufactured in accordance with the present invention each include a varying thickness or height above the surface 18 of the substrate 10. It may be particularly preferred that the thickness variations be provided in the form of a thinner discrete polymeric region proximate the edges 15 of the reinforcing discrete polymeric region 14.

The combination of thicker central portions of the reinforcing discrete polymeric region 14 and thinner edges 15 may provide advantages. The thinner edges 15 may be more flexible or softer, which may enhance comfort if the composite web including such discrete polymeric regions is incorporated into a garment such as, e.g., a diaper, surgical gown, etc. At the same time, the thicker central portion of the reinforcing discrete polymeric region 14 may provide a desired level of rigidity to the discrete polymeric region.

The reinforcing discrete polymeric regions 14 may cover any desired portion of the surface 18 of the substrate 10 on which they are positioned, although it will be understood that the discrete polymeric regions 14 will not cover all of the surface of the substrate 10. Some variations in the percentage of surface area occupied by discrete polymeric regions may be as described in, for example, pending U.S. Patent Application Serial No. 09/257,447, entitled WEB HAVING DISCRETE STEM REGIONS, filed on Feb. 25, 1999 (published as International Publication No. WO 00/50229).

Further, although the discrete polymeric regions 14 are depicted as being disconnected from each other, it should be understood that some composite webs manufactured with the systems and methods of the present invention may include a relatively thin skin layer of the thermoplastic composition used to form the discrete polymeric regions. Such a skin layer may, in some instances, connect some or all of the discrete polymeric regions on the composite web. In any event, however, the amount of polymeric material in the skin layer will be insufficient to provide significant reinforcement of the substrate outside of the thicker discrete polymeric regions.

The substrates used in connection with the composite webs of the present invention may have a variety of constructions. For example, the substrates may be a woven material, nonwoven material, knit material, paper, film, or any other continuous media that can be fed through a nip point. The substrates may have a wide variety of properties, such as extensibility, elasticity, flexibility, conformability, breathability, porosity, stiffness, etc. Further, the substrates may include pleats, corrugations or other deformations from a flat planar sheet configuration.

In some instances, the substrates may exhibit some level of extensibility and also, in some instances, elasticity. Extensible webs that may be preferred may have an initial yield tensile force of at least about 50 gm/cm, preferably at least about 100 gm/cm. Further, the extensible webs may preferably be extensible nonwoven webs.

Suitable processes for making a nonwoven web that may be used in connection with the present invention include, but are not limited to, airlaying, spunbond, spunlace, bonded melt blown webs and bonded carded web formation processes. Spunbond nonwoven webs are made by extruding a molten thermoplastic, as filaments from a series of fine die orifices in a spinneret. The diameter of the extruded filaments is rapidly reduced under tension by, for example, by non-eductive or eductive fluid-drawing or other known spunbond mechanisms, such as described in U.S. Patent Nos. 4, 340,563 (Appel et al.); 3,692,618 (Dorschner et al.); 3,338,992 and 3,341,394 (Kinney); 3,276,944 (Levy); 3,502,538 (Peterson); 3,502,763 (Hartman) and 3,542,615 (Dobo et al.). The spunbond web is preferably bonded (point or continuous bonding).

The nonwoven web layer may also be made from bonded carded webs. Carded webs are made from separated staple fibers, which fibers are sent through a combing or carding unit which separates and aligns the staple fibers in the machine direction so as to form a generally machine direction-oriented fibrous nonwoven web. However, randomizers can be used to reduce this machine direction orientation.

Once the carded web has been formed, it is then bonded by one or more of several bonding methods to give it suitable tensile properties. One bonding method is powder bonding wherein a powdered adhesive is distributed through the web and then activated, usually by heating the web and adhesive with hot air. Another bonding method is pattern bonding wherein heated calender rolls or ultrasonic bonding equipment are used to bond the fibers together, usually in a localized bond pattern though the web can be bonded across its entire surface if so desired. Generally, the more the fibers of a web are bonded together, the greater the nonwoven web tensile properties.

Airlaying is another process by which fibrous nonwoven webs useful in the present invention can be made. In the airlaying process, bundles of small fibers usually having lengths ranging between about 6 to about 19 millimeters are separated and entrained in an air supply and then deposited onto a forming screen, often with the assistance of a vacuum supply. The randomly deposited fibers are then bonded to one another using, for example, hot air or a spray adhesive.

Meltblown nonwoven webs may be formed by extrusion of thermoplastic polymers from multiple die orifices, which polymer melt streams are immediately attenuated by hot high velocity air or steam along two faces of the die immediately at the location where the polymer exits from the die orifices. The resulting fibers are entangled into a coherent web in the resulting turbulent airstream prior to collection on a collecting surface. Generally, to provide sufficient integrity and strength for the present invention, meltblown webs must be further bonded such as by through air bonding, heat or ultrasonic bonding as described above.

A web can be made extensible by skip slitting as is disclosed in, e.g., International Publication No. WO 96/10481 (Abuto et al.). If an elastic, extensible web is desired, the slits are discontinuous and are generally cut on the web prior to the web being attached to any elastic component. Although more difficult, it is also possible to create slits in the nonelastic web layer after the nonelastic web is laminated to the elastic web. At least a portion of the slits in the nonelastic web should be generally perpendicular (or have a substantial perpendicular vector) to the intended direction of extensibility or elasticity (the at least first direction) of the elastic web layer. By generally perpendicular it is meant that the angle between the longitudinal axis of the chosen slit or slits and the direction of extensibility is between 60 and 120 degrees. A sufficient number of the described slits are generally perpendicular such that the overall laminate is elastic. The provision of slits in two directions is advantageous when the elastic laminate is intended to be elastic in at least two different directions.

A nonwoven web used in connection with the present invention can also be a necked or reversibly necked nonwoven web as described in U.S. Patent Nos. 4,965,122; 4,981,747; 5,114,781; 5,116,662; and 5,226,992 (all to Morman). In these embodiments the nonwoven web is elongated in a direction perpendicular to the desired direction of extensibility. When the nonwoven web is set in this elongated condition, it will have stretch and recovery properties in the direction of extensibility.

The substrates used in connection with the present invention may preferably exhibit some porosity on one or both of the major surfaces of the substrate such that when a molten thermoplastic composition is provided on one of the major surfaces of the substrate, a mechanical bond is formed between the molten thermoplastic composition and the substrate as the molten thermoplastic composition infiltrates and/or encapsulates a portion of the porous surface of the substrate. As used in connection with the present invention, the term "porous" includes both structures that include voids formed therein, as well as structures formed of a collection of fibers (e.g., woven, nonwoven, knit, etc.) that allow for the infiltration of molten thermoplastic composition into the interstices between fibers. If the porous surface includes fibers, the thermoplastic composition may preferably encapsulate fibers or portions of fibers on the surface of the substrate.

The type and construction of the material or materials in the substrate should be considered when selecting an appropriate substrate to which a molten thermoplastic composition is applied. Generally, such materials are of the type and construction that do not melt, soften, or otherwise disintegrate under the temperatures and pressures experienced during the step of transferring the thermoplastic composition to the substrate. For example, the substrate should have sufficient internal strength such that it does not fall apart during the process. Preferably, the substrate has sufficient strength in the machine direction at the temperature of the transfer roll to remove it intact from the transfer roll.

As used herein, the term "fiber" includes fibers of indefinite length (e.g., filaments) and fibers of discrete length, e.g., staple fibers. The fibers used in connection with the present invention may be multicomponent fibers. The term "multicomponent fiber" refers to a fiber having at least two distinct longitudinally coextensive structured polymer domains in the fiber cross-section, as opposed to blends where the domains tend to be dispersed, random, or unstructured. The distinct domains may thus be formed of polymers from different polymer classes (e.g., nylon and polypropylene) or be formed of polymers from the same polymer class (e.g., nylon) but which differ in their properties or characteristics. The term "multicomponent fiber" is thus intended to include, but is not limited to, concentric and eccentric sheath-core fiber structures, symmetric and asymmetric side-by-side fiber structures, island-in-sea fiber structures, pie wedge fiber structures, and hollow fibers of these configurations.

Although the substrates depicted in the various cross-sectional views of the articles manufactured according to the methods of the present invention are illustrated as single layer structures, it should be understood that the substrates may be of single or multi-layer construction. If a multi-layer construction is used, it will be understood that the various layers may have the same or different properties, constructions, etc. Some of these variations may be as described in, for example, pending U.S. Patent Application Serial No. 09/257,447, entitled WEB HAVING DISCRETE STEM REGIONS, filed on Feb. 25, 1999 (published as International Publication No. WO 00/50229).

The discrete polymeric regions 14 may be formed of a wide variety of different nonelastomeric thermoplastic polymeric materials. As used in connection with the present invention, "thermoplastic" (and variations thereof) means a polymer or polymeric composition that softens when exposed to heat and returns to its original condition or near its original condition when cooled to room temperature. The thermoplastic compositions used in connection with the methods of the present invention should be capable of flowing or entering into depressions formed in a polymer transfer roll as will be described below.

Suitable thermoplastic compositions are those that are melt processable. Such polymers are those that will flow sufficiently to at least partially fill the depressions, yet not significantly degrade during a melt process. A wide variety of thermoplastic compositions have suitable melt and flow characteristics for use in the process of the present invention depending on the geometry of the depressions and the processing conditions. It may further be preferred that the melt processable materials and conditions of processing are selected such that any viscoelastic recovery properties of the thermoplastic compositions do not cause them to significantly withdraw from the wall(s) of the depressions until transfer of the thermoplastic composition to a substrate is desired.

Some examples of nonelastomeric thermoplastic compositions that may be used in connection with the present invention include, but are not limited to, polyurethanes, polyolefins (e.g., polypropylenes, polyethylenes, etc.), polystyrenes, polycarbonates, polyesters, polymethacrylates, ethylene vinyl acetate copolymers, ethylene vinyl alcohol copolymers, polyvinylchlorides, acrylate modified ethylene vinyl acetate polymers, ethylene acrylic acid copolymers, nylons, fluorocarbons, etc.

A nonelastomeric thermoplastic polymer is one that melts and returns to its original condition or near its original condition upon cooling and which does not exhibit elastomeric properties at ambient conditions (e.g., room temperature and pressure). As used in connection with the present invention, "nonelastomeric" means that the material will not substantially resume its original shape after being stretched. Further, the nonelastomeric materials may preferably sustain permanent set following deformation and relaxation, which set is preferably at least about 20 percent or more, and more preferably at least about 30 percent or more of the original length at moderate elongation, e.g., about 50% (for those materials that can even be stretched up to 50% without fracture or other failure).

The nonelastomeric thermoplastic compositions used in connection with the present invention can also be combined with various additives for desired effect. These include, for example, fillers, viscosity reducing agents, plasticizers, tackifiers, colorants (e.g., dyes or pigments), antioxidants, antistatic agents, bonding aids, antiblocking agents, slip agents, stabilizers (e.g., thermal and ultraviolet), foaming agents, microspheres, glass bubbles, reinforcing fibers (e.g., microfibers), internal release agents, thermally conductive particles, electrically conductive particles, and the like. The amounts of such materials that can be useful in the thermoplastic compositions can be readily determined by those skilled in the art of processing and using such materials.

FIG. 2 is a plan view of a portion of the exterior surface of one transfer tool that can be used to deposit the reinforcing discrete polymeric region 14 on the substrate 10 depicted in Figure 1. That depicted portion of the exterior surface 32 includes a depression 34 formed therein. FIG. 2 also depicts a number of smaller depressions 38 dispersed over the surface 32 of the transfer roll. Each of the depressions 38 is smaller than the larger depression 34, both in terms of footprint (see below) as well as depression volume. The smaller depressions 38 may also fill with molten thermoplastic composition during use of the transfer roll, with the smaller discrete polymeric regions formed by the depressions 38 serving a variety of purposes as discussed in connection with FIGS. 7-9 below.

The depression 34 is preferably a composite of cells 34a, 34b, 34c and 34d formed in the surface 32 by any suitable technique, e.g., machining, etching, laser ablation, etc. FIGS. 3A-3C depict one set of steps that can be used to manufacture a composite depression 34 in the transfer roll 30 as seen in FIG. 2. The views in FIGS. 3A-3C are taken along line 3-3 in FIG. 2 and, as a result, do not include the smallest cells 34d seen in FIG. 2.

Further, the complete outline of each of the cells is depicted in FIG. 2 for a better understanding of the invention, although it will be understood that portions of each of the cells may not actually be visible in the finished composite depression 34. In addition, the depicted composite depression 34 is made of a multiple circular cells 34a-34d. It should, however, be understood that composite depressions according to the present invention may be made of cells having any selected shape, e.g., oval, square, triangular, etc. Further, the composite depressions of the present invention may be constructed of cells having a variety of shapes and/or sizes.