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(54) **ELASTIC LAMINATES PREPARED BY
MULTIPLE STRETCHING STEPS**

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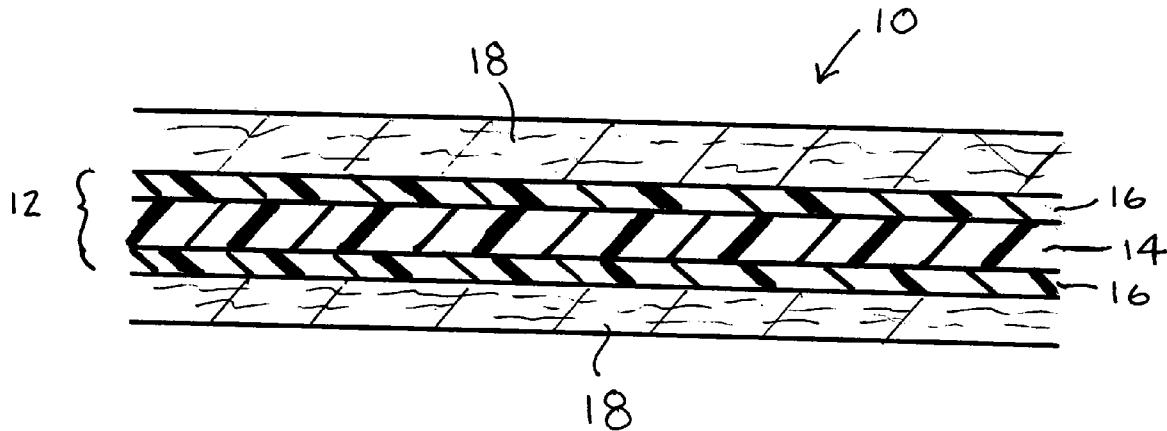
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(57) **ABSTRACT**

Elastic laminates and methods of making same are provided, wherein the laminate includes an elastic film laminated to at least one substrate web, and wherein the elastic film has been stretched at least twice prior to bonding the film to the substrate layer. Such laminates possess improved bond strength between the film and the substrate web and have greater elongation versus laminates made with a film that has been stretched only once.



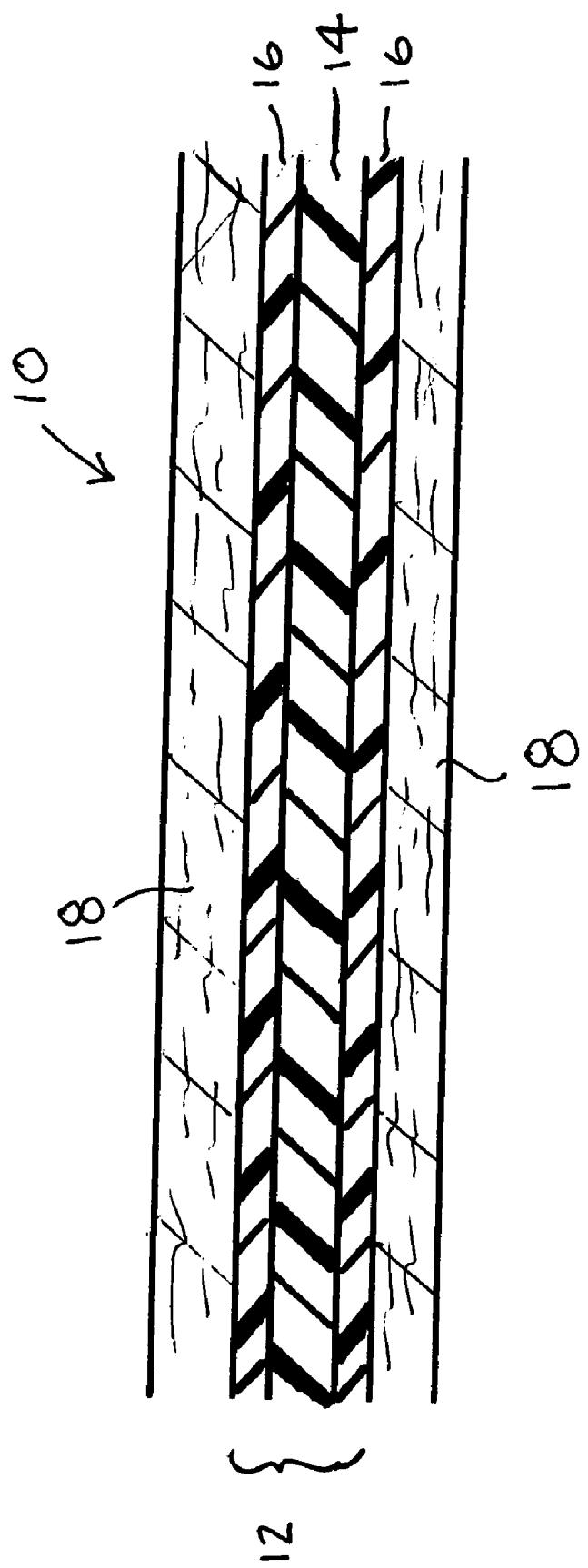


FIG. 1

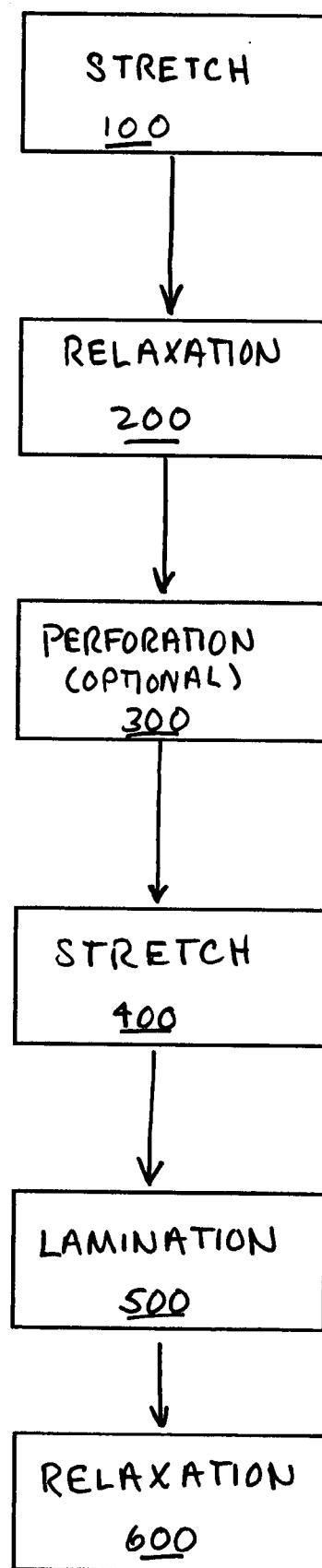


FIG. 2

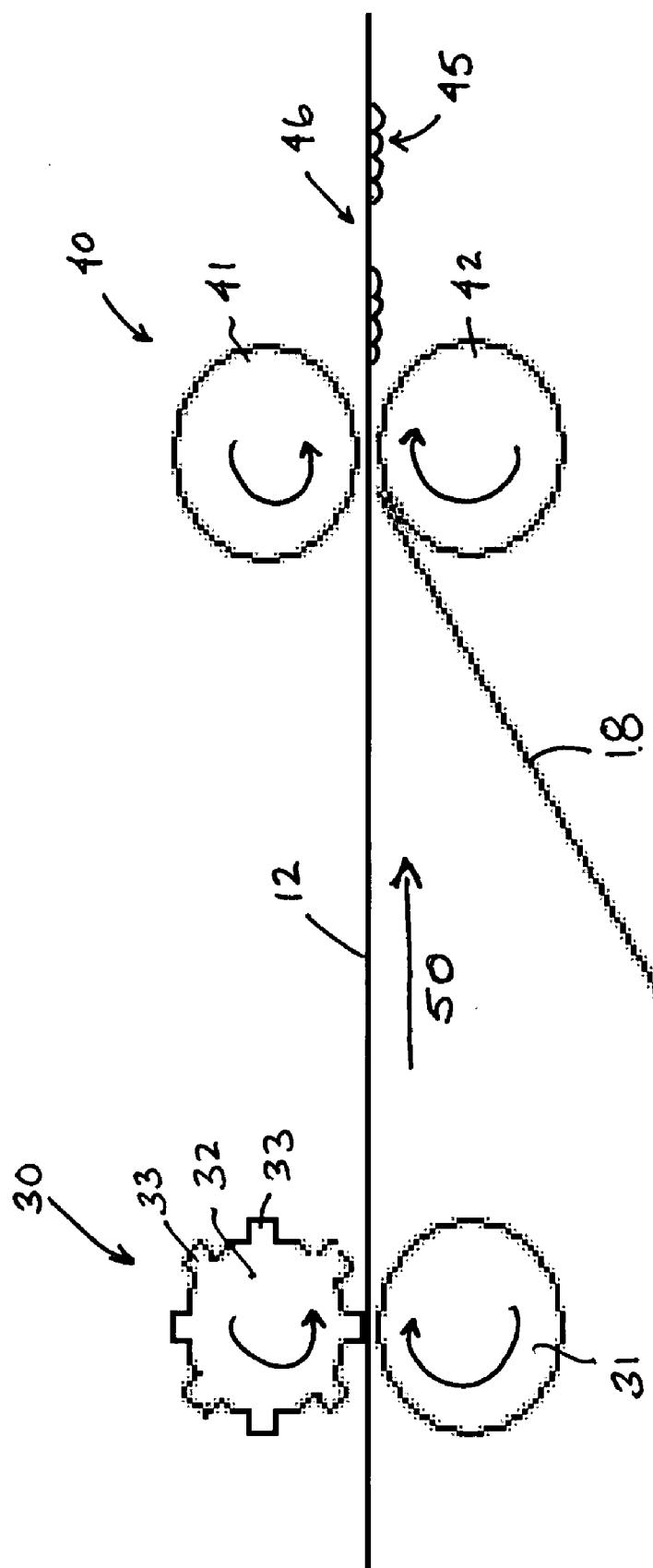


Fig. 3

Fig. 4

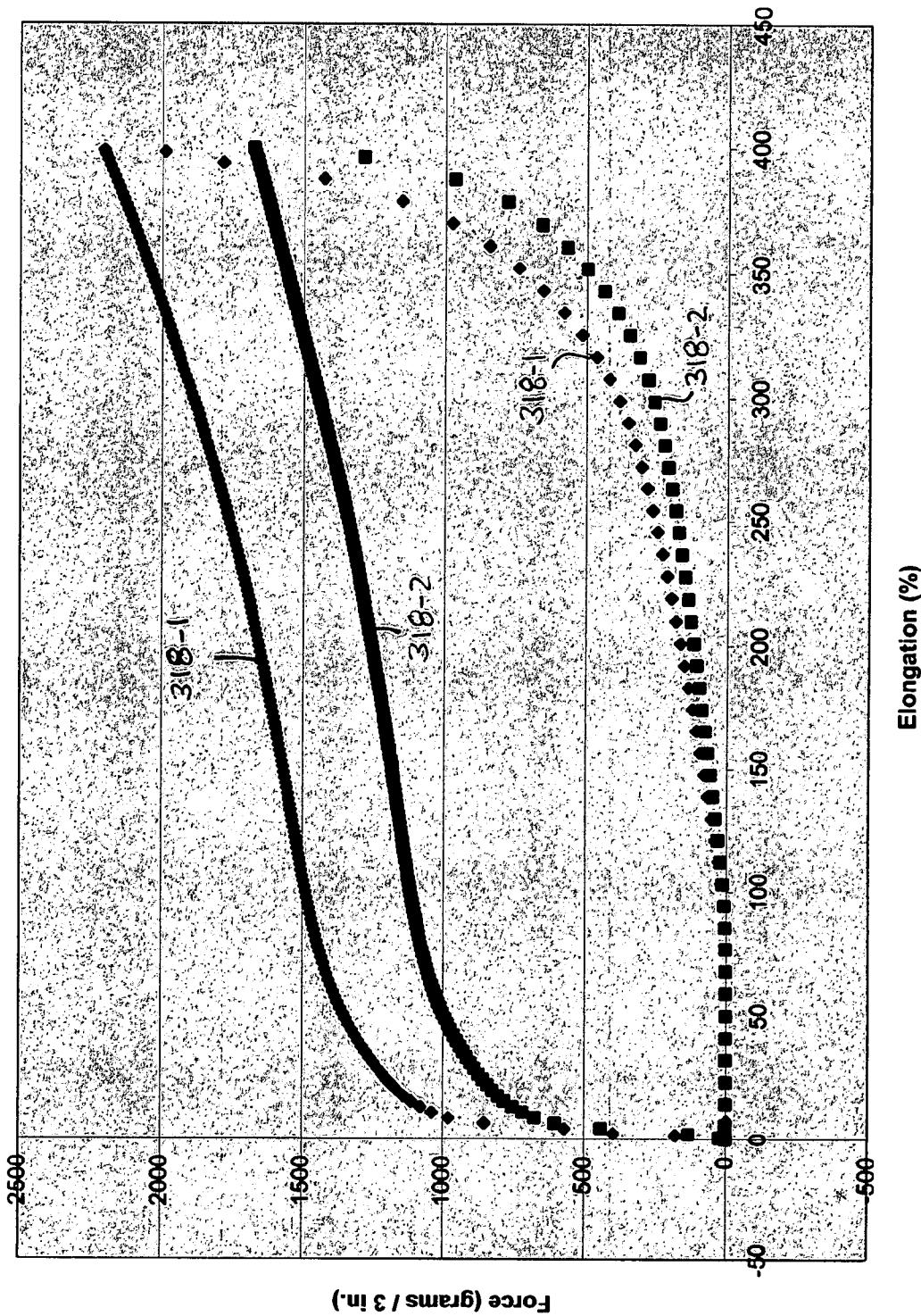


Fig. 5

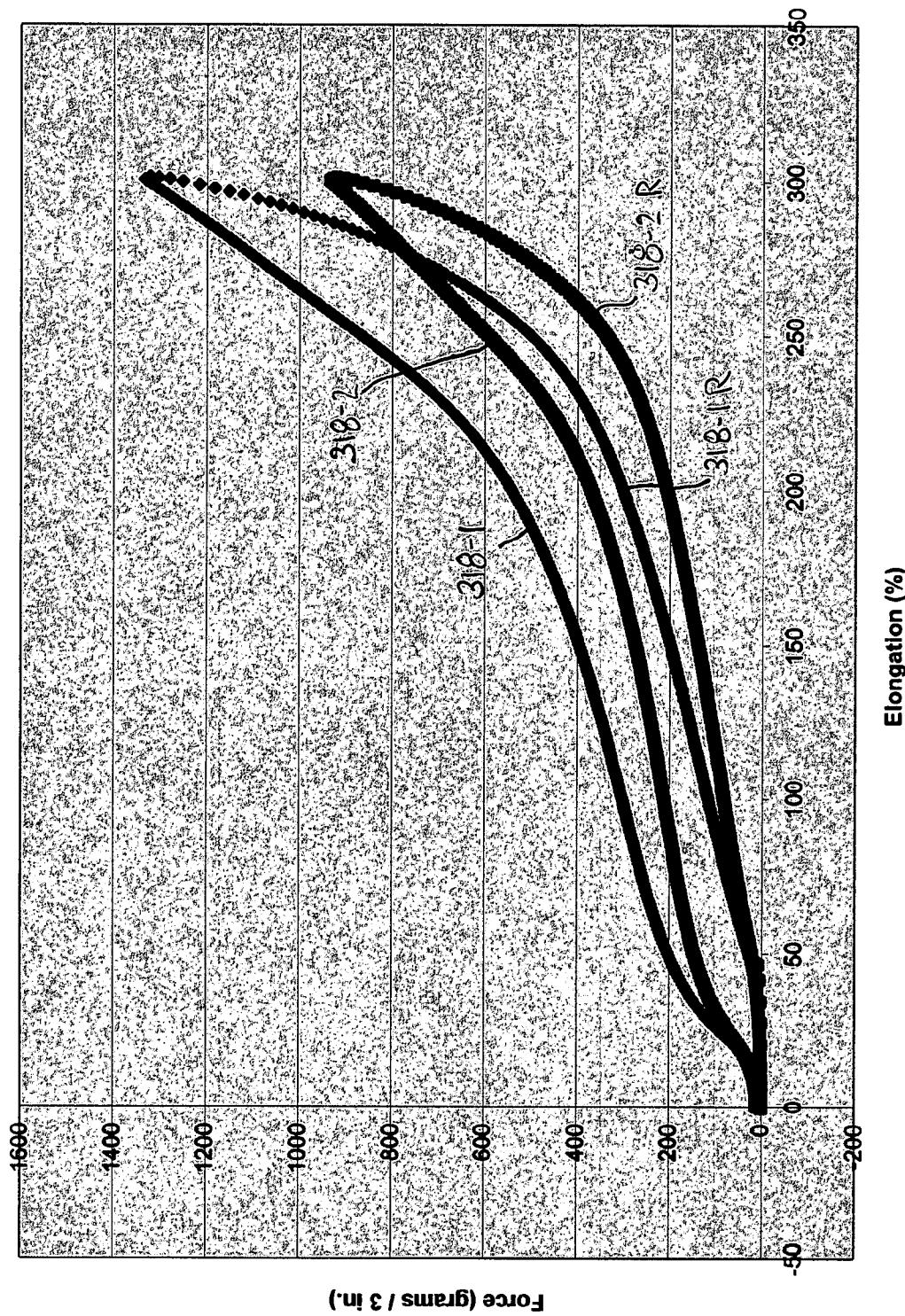


Fig. 6

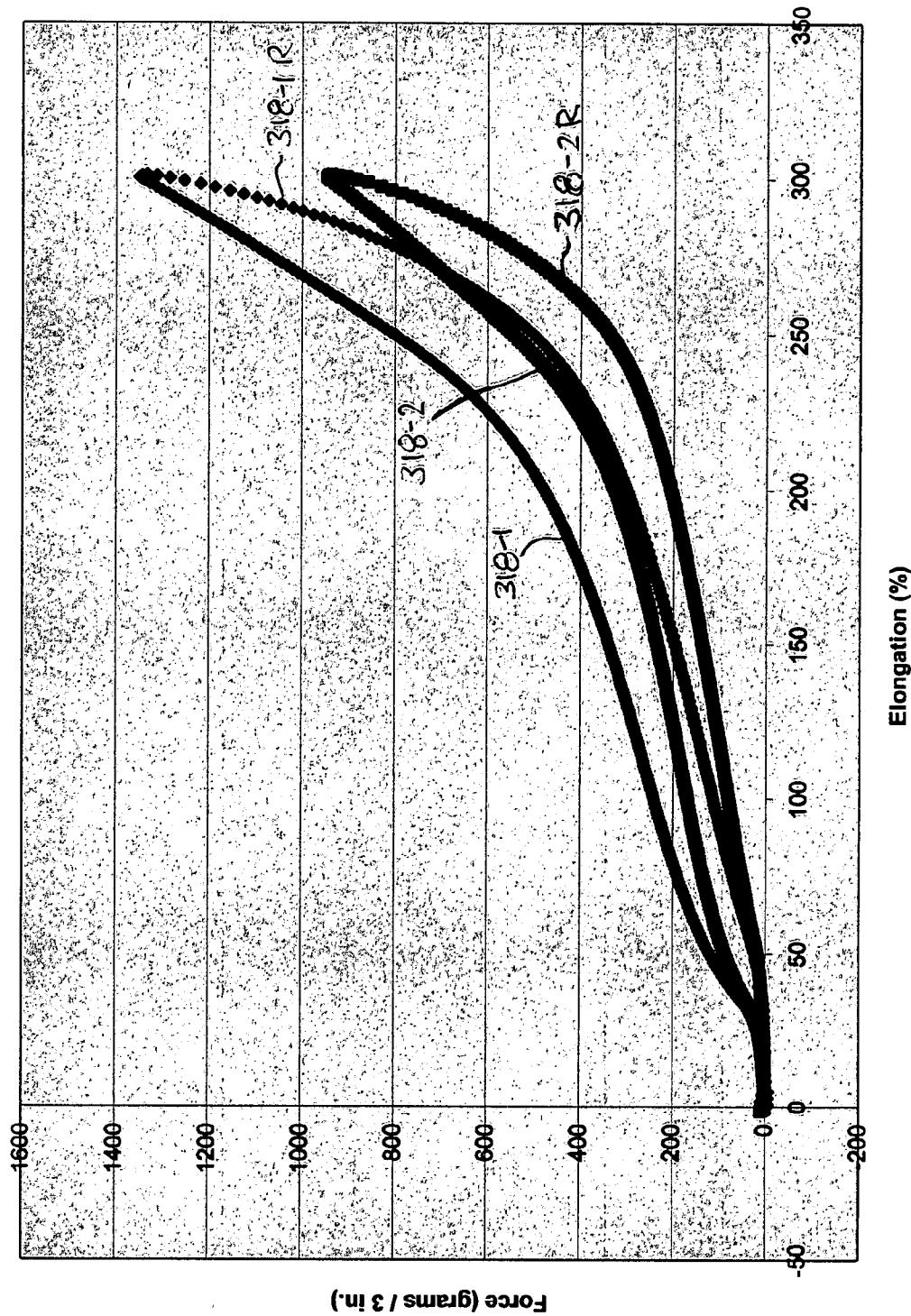


FIG 7

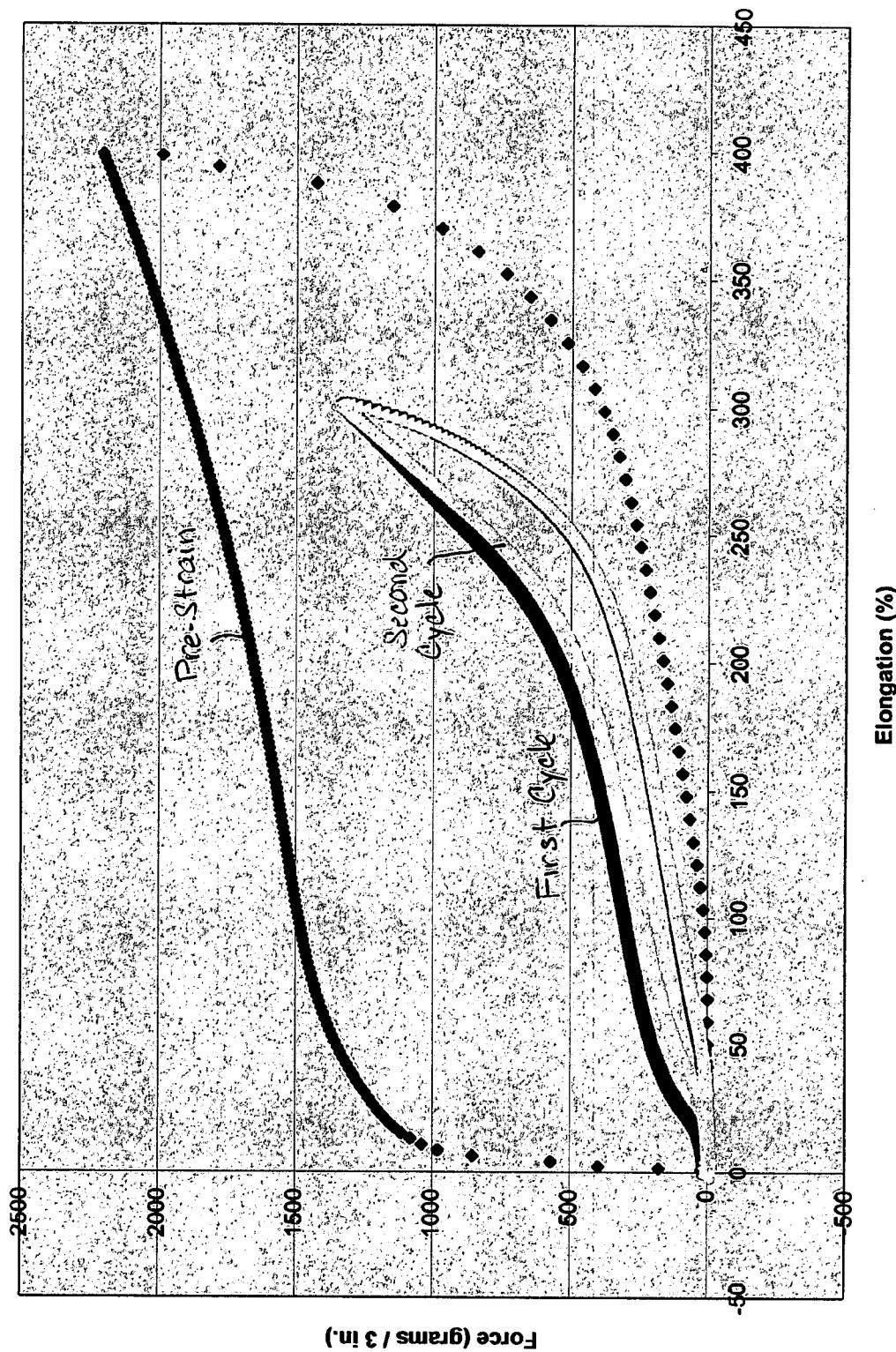
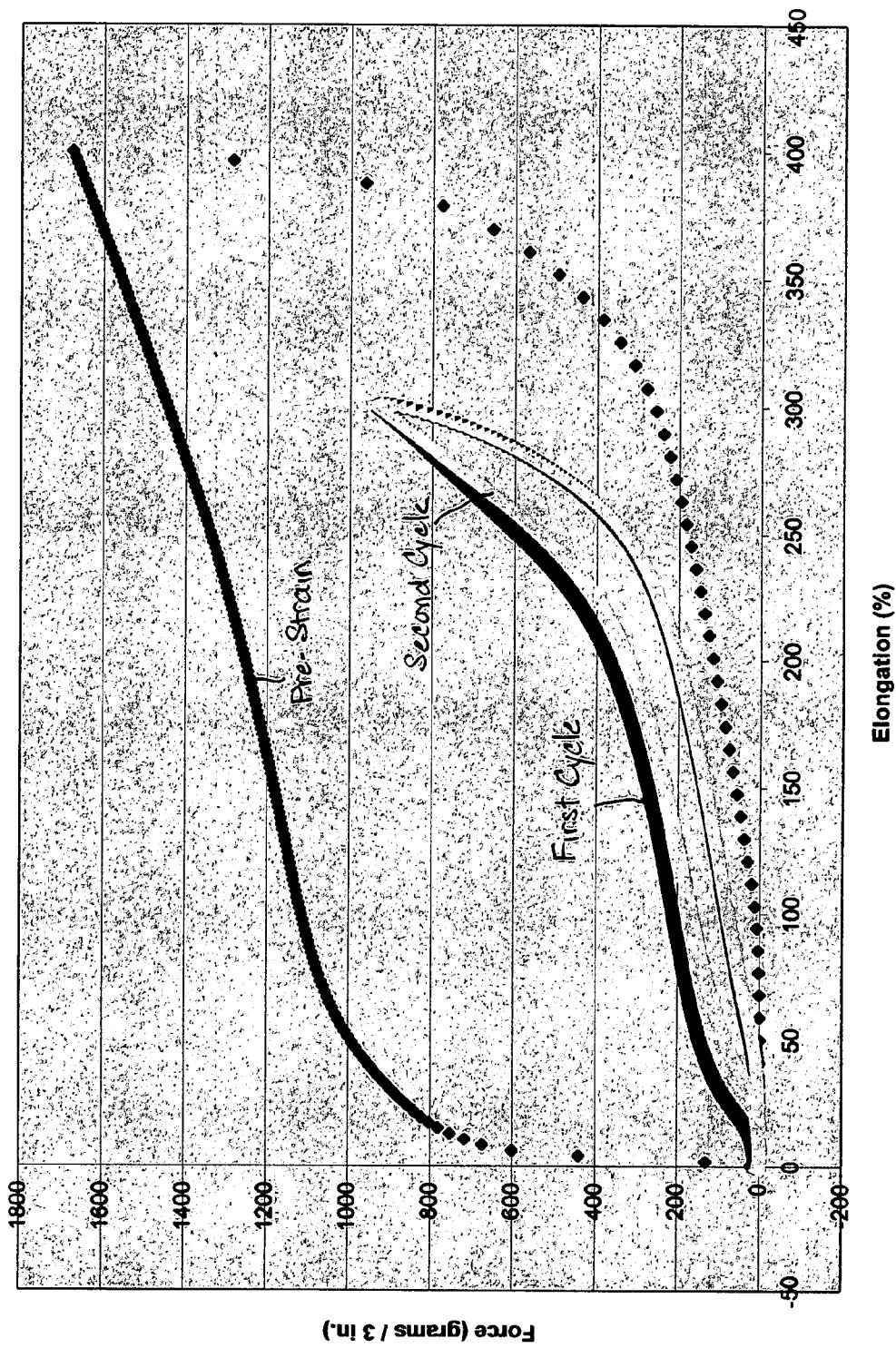


Fig 8



ELASTIC LAMINATES PREPARED BY MULTIPLE STRETCHING STEPS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional Application No. 60/790,663, filed Apr. 10, 2006 and entitled "Elastic Film Laminates, Articles and Methods of Manufacturing Same".

FIELD OF THE DISCLOSURE

[0002] The disclosure relates to elastic film laminates, methods of manufacturing such laminates and articles incorporating same.

BACKGROUND OF THE DISCLOSURE

[0003] Elastic film laminates are used in the manufacture of many goods. In particular, elastic film laminates are used in the manufacture of absorbent articles, such as diapers, training pants adult incontinent articles, and similar articles. The elastic film laminates may be used, for example, as the waist band, leg cuffs, side tabs, side ears, side panels or as the shell of the article. Elastic film laminates also find use in other articles, such as garments, hats, gowns, coveralls, etc. and are typically used to provide desired fit characteristics to the article.

[0004] When a film or laminate is made in roll form, the material travels along a path known as the machine direction ("MD") beginning where the material is formed or unwound to the point where the finished web is wound on a roll. The machine direction will normally correspond to the longest dimension of the web. The cross direction ("CD") is a direction generally perpendicular to the machine direction and will typically correspond to the width of the web. A number of elastic films and laminates have been proposed, but the vast majority of such films and laminates are engineered and constructed to provide stretch in the cross direction ("CD").

[0005] Heretofore, the most common form of elastic laminate having stretch in the machine direction have not used film, but instead have employed a laminate of elastic strands, such as strands of LYCRA® brand elastomer. In the manufacture of elastic strand laminates, the strands are placed under tension and adhesively laminated to at least one, and typically two nonwoven fibrous webs. The nonwoven webs provide a cloth like texture to the laminate which is preferred by the consumer, as is known. The elastic strands are then allowed to relax, causing the nonwoven to gather and pucker, resulting in a bulky appearance. In some applications, such as training pants and adult incontinent articles, the bulky appearance is objectionable. In order to make the resulting laminate smoother and less bulky, the number of elastic strands used needs to be increased approximately three-fold. The increased number of elastic strands adds to the cost of the laminate, and also results in significantly more complicated and less robust manufacturing process. The increased number of strands becomes difficult to manage and, if any of the strands would break, the process needs to be stopped for a considerable period of time while the strand(s) are re-threaded into the machine.

[0006] Accordingly, there is a need for a smoother, less bulky elastic film laminate that has improved properties and can be manufactured in a robust process.

SUMMARY OF THE DISCLOSURE

[0007] In one embodiment, the invention provides a method of making an elastic film laminate, the method comprises stretching the film in multiple steps prior to laminating the film to at least one substrate.

[0008] In another embodiment, the invention provides an elastic film laminate comprising an elastic film bonded to at least one substrate, wherein the film has been stretched in multiple steps prior to being bonded to the substrate.

[0009] In yet another embodiment, the invention provides an article of clothing comprising an elastic film laminate, wherein the film laminate comprises an elastic film bonded to at least one substrate, wherein the film has been stretched in multiple steps prior to being bonded to the substrate.

[0010] These and other aspects of the invention will become apparent upon a further reading of the specification with reference to the drawing figures and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a schematic diagram outlining the steps in an exemplary process of making an elastic film laminate according to the invention.

[0012] FIG. 2 is a schematic illustration of an elastic film laminate in accordance with the invention.

[0013] FIG. 3 is a schematic illustration of an intermittent stretching process that may be used in the invention.

[0014] FIG. 4 is a graph plotting percent elongation versus force of a first stretch cycle of an embodiment.

[0015] FIG. 5 is a graph plotting percent elongation versus force of a second stretch cycle of an embodiment.

[0016] FIG. 6 is a graph plotting percent elongation versus force of a third stretch cycle of an embodiment.

[0017] FIG. 7 is a composite graph plotting percent elongation versus force for three stretch cycles of an embodiment having a basis weight of 40 gsm.

[0018] FIG. 8 is a composite graph plotting percent elongation versus force for three stretch cycles an embodiment having a basis weight of 30 gsm.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0019] With reference first being made to FIG. 1, illustrated therein is one embodiment of an elastic film laminate in accordance with the invention. As used herein, the term "elastic film laminate" connotes a structure comprising an elastic film bonded to at least one substrate. The elastic film laminate 10 shown in FIG. 1 comprises an elastic film 12 having an elastomeric core 14. Preferably the film 12 further comprises at least one skin layer 16 disposed on at least one side of the elastomeric core 14. Most preferably, the core 14 will have at least one skin layer 16 on each side thereof, as illustrated in FIG. 1. It is to be understood that embodiments having more than one skin layer on each side of the elastic core 14 are also contemplated and may be used to advantage. Attached to the elastic film 12 is at least one substrate, such as nonwoven web 18. In a preferred embodiment, the laminate will comprise a nonwoven web 18 attached to each side of the elastic film 12.

[0020] As noted, the elastic film **12** comprises an elastic core **14** and, optionally, one or more skin layers **16**. The elastomeric core **14** comprises natural or synthetic rubbers, such as isoprenes, butadiene-styrene materials, styrene block copolymers (e.g., styrene/isoprene/styrene (SIS), styrene/butadiene/styrene (SBS), or styrene/ethylene-butadiene/styrene (SEBS) block copolymers) olefinic elastomers, polyetheresters, polyurethanes, for example, and mixtures thereof.

[0021] If one or more skin layers **16** are to be used with elastic core **14**, it is preferable that the elastic film **12** be made in a co-extrusion process, in which the elastic core **14** and the one or more skin layers **16** are extruded simultaneously from a die. Alternatively, processes such as extrusion coating could be used to produce the multilayer film **12**. The skin layers **16**, if used, can comprise any suitable material that is less elastic than the elastic core **14**. Preferred materials are polyolefin polymers, specifically polyethylene polymers and copolymers, including metallocene-catalyzed polyethylene and blends of polyethylene polymers or copolymers. Other materials, such as vinyl acetate copolymers, may also be used to advantage if desired.

[0022] The relative amounts of skin layer **16** to core layer **14** in the elastic film **12** can vary depending on the particular application and the desired properties. Preferred embodiments for a multilayer elastic film **12** range from 5/90/5 to 15/70/15 by weight of skin/core/skin. The elastic film **12** may be embossed using a textured roller, as is known in the art, or may be made with a smooth surface. For example, a vacuum box may be employed to advantage to make a film with a smooth surface. The vacuum box imparts a partial vacuum to the elastic film **12** during the manufacturing process, drawing the film against a cast roll, producing a film that is smoother and generally of a thinner gauge than those produced without a vacuum box.

[0023] The nonwoven webs **18** may be bonded to the elastic film **12** in any suitable manner, such as, for example, by adhesive bonding, ultrasonic bonding, thermal bonding, point bonding, or other suitable method. Combinations of bonding methods may also be employed.

[0024] The term "nonwoven web" connotes a web of fibers interlaced and intertwined, but not in any regular or repeating pattern. Nonwoven fibrous webs are well known in the art and widely available. Such webs can comprise spunbonded, meltblown or carded webs, for example and can be monofilament fibers or bi-component fibers having a core-sheath structure. The nonwoven web **18** may be extensible, inextensible, elastic or inelastic. The term "elastic" is used to connote a material that can be stretched in at least one direction to approximately 150% of its original dimension and, when the tension is released, will return to a dimension that is no greater than 125% of its original dimension. For example, a material that is one inch long is elastic if it can be stretched to 1.5 inches in length and will return to be no more than 1.25 inches when the tension is released and the material is allowed to relax.

[0025] With reference now being made to FIG. 2, a schematic diagram of an exemplary process for making a laminate in accordance with the invention is depicted. After the elastic film **12** is formed, it undergoes a first stretching step **100**. In the first or initial stretching step **100**, the elastic film **12** is elongated or stretched in an amount sufficient to reduce the recovery force of the film. The amount of stretch necessary to accomplish this end point will vary with the

type of elastomer used, the specific construction of the film, the basis weight of the film, and similar considerations. In preferred embodiments, the film is stretched to 400% or more in the initial stretching step **100**. In particularly preferred embodiments, the film is stretched in the machine direction, although it could be stretched in the cross direction in lieu of or in addition to stretching in the machine direction.

[0026] The stretching in step **100** can be accomplished by any known and suitable stretching process and apparatus. For example, the film can be run through two sets of spaced-apart rollers, with the downstream pair of rollers operating at a higher rate of speed than the upstream pair to elongate the film in the MD. Alternatively, the film could be subjected to a tenter frame to orient the film in the CD if so desired. Or the film could be subjected to an intermeshing gear ("IMG") stretching operation in which the film is forced through a nip formed by two complimentary toothed rollers in a mating relationship. As the film passes through the nip formed by the intermeshing teeth of the rollers, it elongates and is stretched. IMG stretching can be accomplished in either the MD or CD as desired. Other stretching operations known in the art, or combinations of stretching methods, may also be used to advantage. If skins **16** are present in the elastic film **12**, the stretching step **100** will be sufficient to deform the skins and thus permit the elastic core to elongate and retract, as is known in the art.

[0027] After the film is stretched in the initial stretching step **100**, the film **12** is allowed to relax during the relaxation step **200**. At this point, the film is generally not under any appreciable tension, except that necessary to carry the film in the MD and to support the film during any processing that might take place prior to the next stretching operation. For example, while the film is relaxed during this step, it is advantageous to process the film to impart breathability, if desired, at the optional perforation step **300**.

[0028] Processes to impart breathability include perforation, slitting and other techniques, such as hot needle perforation, die cutting, scoring, shearing, or through the use of high pressure water jets. Combinations of such methods may also be employed. Applicants have discovered that the film **12** is less prone to tearing or breaking if the perforations are added after the initial stretching step **100** as compared to perforating the film before the first stretching step. The perforations or slits, if used, may be introduced selectively, that is, only in pre-determined areas of the film **12**. The number, size and shape of the perforations will be determined by the particular desired properties of the finished laminate. The perforations may also permit better handling of the film with a "cut-and-place" apparatus, as more fully described below.

[0029] Although not particularly preferred, breathability can be imparted by using a vacuum forming process in making the elastic film **12**. Such an embodiment is not preferred because the film has a greater tendency to tear, rip or break during stretching if apertured before the first stretching step **100**. Similarly, breathability may be imparted to the film **12** subsequent to the second stretching step **400**, if desired.

[0030] Subsequent to the relaxation step **200** and any optional perforation of the film, the film **12** is again stretched during stretching step **400**. As with first stretching step **100**, the process or apparatus used to stretch the film **12** is not material to the invention. The degree of stretch during step

400 is equal to or less than the amount of stretch imparted during the first stretching step **100**. In preferred embodiments, the degree of stretch during the second stretching step **400** is less than that imparted in first stretching step **100**. For example, if the film **12** is stretched by 300% (equivalent to a 4:1 draw ratio) during the first stretch step **100**, it may be stretched by 210% (3.1:1 draw ratio) during the second stretch step **400**. Similarly, if the film **12** is stretched 400% (5:1 draw ratio) during the first stretch step **100**, it may be stretched no more than 350% (4.5:1 draw ratio) during the second stretching step **400**.

[0031] Because the film has been pre-stretched during step **100**, the force needed to stretch the film a second time will decrease, and may decrease by up to 80%. In addition, the first stretching step **100** results in the film having reduced recovery forces, that is, the force exerted by the film as it tries to resume its original dimension. Thus, less force is required to maintain the film under tension during second stretching step **400**.

[0032] It should be noted that the process depicted in FIG. 2 shows only two stretching steps, which is the minimum number of stretching steps in accordance with the invention. However, more than two stretching steps may be employed if desired.

[0033] While the film is still in a stretched condition during second (or subsequent) stretching step **400**, it may advantageously be attached to the nonwoven web(s) **18** if desired during the lamination step **500**. Bonding the nonwoven(s) to the film while the film is stretched will result in the nonwoven webs being gathered when the tension on the film is released. The laminate will then be able to extend at least to the point that the film was stretched at the time of bonding to the nonwoven, without destroying or disrupting the bonds or deforming the fibers in the nonwoven web.

[0034] Applicants have discovered that the process of the invention results in improved bond strength between the film and the nonwoven web(s). While not intending to be bound by any particular theory, Applicants believe that the lower recovery forces in the elastic film reduces the forces that the film exerts in trying to pull away from the nonwoven web(s), resulting in a stronger bond.

[0035] During the lamination step **500**, the film **12** is laminated to one or more nonwoven web(s) **18**. The lamination may be accomplished using any suitable technique, such as, for instance, adhesive lamination, thermal bonding, ultrasonic bonding, pressure bonding or dynamic mechanical bonding. Combinations of such techniques may also be employed to advantage.

[0036] Following the lamination step **500**, the resulting laminate **10** is allowed to relax during relaxation step **600**. Surprisingly, the laminate formed by a multiple stretch process has greater elongation than a laminate made using a single stretch process.

[0037] The lower recovery forces (which can also be viewed as the force necessary to hold the film in a stretch condition) following relaxation step **200** can also be advantageous when the film is being used in a cut-and-place type apparatus. Cut-and-place type apparatus are used in many diaper manufacturing operations and in other industrial processes. These apparatus typically use a vacuum pressure to maintain a material in place while the material is cut into a desired size or shape, and then place or move the cut piece of material to another location in the process.

[0038] In the context of the present invention, a cut-and-place apparatus may be used in a diaper manufacturing operation to form, for example, a side ear or side panel for a diaper. Specifically, the elastic film **12** may undergo a first stretching operation **100**, relaxation step **200** and optional perforation step **300** at the location of manufacture. The material may then be wound on a roll and sent to the diaper manufacturer, where the film is unwound and undergoes the second stretch operation **400**. While the film is under tension during stretching step **400**, it is brought into contact with the vacuum device and is cut to the desired size and shape. As soon as the material is cut, the only force holding it under tension is the vacuum pressure. At this point, the cut piece of film is laminated to the nonwoven web(s) and the lamination step **500**, whereupon it is released from the vacuum. At this point the elastic film is still held under tension by the nonwoven web and if another nonwoven web is to be laminated, is maintained under tension until the second nonwoven web is attached, after which it is allowed to relax at step **600**.

[0039] It is apparent from this description that the recovery forces of the elastic film need to be matched to the ability of the cut-and-place apparatus to retain the material under tension. Apart from the recovery forces, such factors as coefficient of friction need to be considered. However, all things being equal, pre-stretching the elastic film in accordance with the invention provides a convenient, cost-effective solution without having to reduce the basis weight of the film, add tackifiers to the skin layers (which can be detrimental to film handling concerns) or take other measures.

[0040] Although the embodiments discussed reference bonding the elastic film to one or more nonwoven web(s), it is understood that other substrates may be used if desired. Examples of suitable substrates include thermoplastic film material, such as polyethylene, polypropylene, ethylene vinyl acetate and other such polymeric materials; fibrous material (which can comprise a fibrous web, woven and/or non-woven materials, including polyesters, polyolefins, acrylics, rayons, cottons and other cellulose materials, thermoplastic elastomers, and blends of the same, etc.).

[0041] The embodiments described in detail contemplate that the film **12** is stretched relatively uniformly along its length, width or both. However, it is understood that certain embodiments may provide for the film to be stretched intermittently or only in certain areas, to provide for desired laminate properties. For example, IMG stretching is one form of intermittent stretching because the points where the film contacts the teeth of the rollers act as grip points. The film does not stretch at the grip points, but does stretch at locations immediately adjacent to the grip points. As the depth of IMG activation increases, the length of the stretched area increases until the entire region of the film located between the teeth is stretched.

[0042] Another example of intermittent stretching is illustrated in FIG. 3 and comprises the use of two nips, the first nip **30** formed of a smooth roller **31** and a ribbed roller **32** and the second nip **40** formed of two smooth rollers **41, 42**. The ribbed roller has parallel, raised sections or ribs **33** that run the length of the roller (i.e., into and out of the plane of the paper as seen in FIG. 3). As the roller rotates, the film **12** is alternately gripped by the raised ribs **33** and released. The rollers **41, 42** of second nip **40** are rotating at a faster rate of speed than the rollers of the first nip. In the embodiment shown in FIG. 3, the film **12** is moving in the direction from

nip 30 toward nip 40, as seen by arrow 50. Thus, as the film 12 is alternately gripped and released by the first nip, the film is intermittently stretched and not stretched. Stretching of film 12 occurs in the region between the first nip 30 and the second nip 40. The speed of rotation of ribbed roller 32, as well as the number of ribs 33, the size and shape of the ribs 33, and the spacing between adjacent ribs 33 on the roller 32 will determine the relative size of the stretched and non-stretched areas. The relative speed of the rollers 41, 42 of the second nip 40 will determine the degree of stretch imparted to the film 12.

[0043] As also seen in FIG. 3, substrate 18 may be introduced at the second nip roller whereby substrate 18 will be laminated to the film 12. The resulting laminate will comprise extensible regions 45 separated by inextensible regions 46 as seen in FIG. 3. The extensible regions will correspond to the locations where the film 12 was under tension while bonded to the substrate 18 and the inextensible regions 46 will correspond to the locations where the substrate 18 was laminated to film 12 while film 12 was not under tension.

[0044] It is contemplated that the ribs 33 may correspond to the width of the film 12, or may be wider or narrower than the film 12. If narrower than the width of the film 12, then the film will only be gripped in a portion along its width corresponding to the location of the ribs 33. Such embodiments can provide even greater variation in the properties of the laminate. In addition, it is contemplated that alternate methods of intermittently gripping and releasing the film may be used in lieu of the ribbed roller 32. For example, both rollers of nip 30 could be smooth and one such roller moved into and out of engagement with the film 112 by use of a rotating cam or other actuator device.

EXAMPLES

[0045] Table 1 illustrates the reduction in force needed to elongate the films between the first and second stretching steps for two films that were identical, except for the difference in basis weight. Because the films require less force to elongate after the first stretch, they also require less force to hold the film in a stretched condition (i.e., they have a reduced recovery force as well).

[0046] In the examples, two films were prepared, one having a basis weight of 30 grams/sq. meter ("gsm") and the other having a basis weight of 40 gsm. The films were first stretched to 400% elongation (reported as the "Pre-Strain" in Table 1) and relaxed. Then the films were stretched to 300% elongation in a second stretching step (reported as "First Cycle" in the table). The force necessary to stretch the films is reported in Table 1.

TABLE 1

| Basis weight | Pre-Strain (400%) | First Cycle (300%) | Force Reduction |
|--------------|-------------------|--------------------|-----------------|
| 30 gsm | 1676 grams | 930 grams | 44.5% |
| 40 gsm | 2200 grams | 1331 grams | 39.5% |

[0047] FIGS. 4-8 plot the data of force versus percentage elongation. Specifically, FIG. 4 shows the force required to initially stretch ("Pre-Strain") the 30 gsm and 40 gsm films to 400% elongation. The curve corresponding to the 40 gsm film is curve 318-1 and the curve representing the 30 gsm film is 318-2. The recovery curves are also shown and

labeled as 318-1R and 318-2R, respectively. FIG. 5 shows a similar graph for the second stretch step ("First Cycle") of the films. The same numbers were used to identify the samples.

[0048] FIG. 6 is a similar graph showing the force necessary to elongate the films to 300% in a third stretching step. As best seen in FIGS. 7 and 8, (which are composite graphs of FIGS. 4-6 for the 40 gsm film and the 30 gsm film, respectively), a significant difference is seen between the force needed to initially stretch the films as compared to the second stretching, yet very little difference in force is required to stretch the film a third of subsequent times.

[0049] Although the present invention has been described with respect to various specific embodiments, various modifications will be apparent from the present disclosure and are intended to be within the scope of the following claims.

We claim:

1. A laminate comprising an elastic film laminated to at least one substrate web, wherein the elastic film has been stretched at least twice steps prior to being laminated to the at least one substrate web.

2. The laminate of claim 1, wherein the elastic film comprises an elastic core and at least one skin layer.

3. The laminate of claim 1, wherein said at least one substrate web comprises a nonwoven web.

4. The laminate of claim 1, wherein said elastic film is perforated.

5. A process of manufacturing a laminate, the process comprising the steps of

- (a) providing an elastic film;
- (b) stretching the film in at least one direction;
- (c) relaxing the film;
- (d) stretching the film at least once more in at least said one direction;
- (e) laminating the film to at least one substrate web while said film is stretched to form a laminate; and
- (f) relaxing the laminate.

6. The process of claim 5, wherein the film is stretched to an equal or lesser degree in step (d) than it is in step (b).

7. The process of claim 5, wherein step (e) comprises laminating the film to at least one nonwoven web.

8. The process of claim 5, wherein said elastic film comprises an elastic core and at least one skin layer.

9. The process of claim 8, wherein said step (a) comprises co-extruding an elastic film having an elastic core and at least two skin layers.

10. The process of claim 5, wherein steps (a) through (c) are performed by a film manufacturer and wherein steps (d) through (e) are performed by an article manufacturer.

11. The process of claim 10, wherein at least a portion of steps (d) through (e) involve the use of a cut-and-place apparatus.

12. The process of claim 5, further comprising the steps of

- (g) winding the film; and
- (h) unwinding the film;

wherein steps (g) and (h) take place between steps (c) and (d).

13. The process of claim 5, further comprising the step of (i) perforating the film;

wherein step (i) takes place between step (a) and step (d).

14. The laminate made from the process of claim 13.

15. The laminate made from the process of claim 5.

16. An article comprising a laminate, said laminate comprising an elastic film laminated to at least one substrate web, wherein the elastic film has been stretched at least twice steps prior to being laminated to the at least one substrate web.

17. The article of claim **16**, wherein said laminate is prepared by a process comprising the steps of

- (a) providing an elastic film;
- (b) stretching the film in at least one direction;
- (c) relaxing the film;

(d) stretching the film at least once more in at least said one direction;

(e) laminating the film to at least one substrate web while said film is stretched to form a laminate; and

(f) relaxing the laminate.

18. The article of claim **16**, wherein said elastic film is perforated.

* * * * *