METHOD FOR IMPROVING CREEP RESISTANCE OF A SUBSTRATE COMPOSITE

We have found that the uniformity and strength of the attachment between one or more elastic strands and a base material, or materials, in a substrate composite is improved by heating the strand. By heating the elastic strand or strands prior to attachment, creep resistance, a measure of the uniformity and strength of adhesion between elastic strand and base material, increases by about 5%, particularly by about 10%, and more particularly by about 15%. Thus, the present invention is directed to improving the uniformity and strength of the attachment of elastic strand to base material by heating the strand prior to attachment. The strand may be heated by thermal conduction and/or convection, by irradiative methods incorporating, for example, infrared radiation or microwave radiation, or some combination of these. If the elastic strand is made at a location different from the location where the strand is used as a raw material, the strand may be heated at either location. Furthermore, the strand may be heated in-line, i.e., as part of the process that makes the strand or the process that uses the strand as a raw material, or off-line, i.e., in a step separate from either of the aforementioned processes.
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METHOD FOR IMPROVING CREEP RESISTANCE OF A
SUBSTRATE COMPOSITE

This application claims priority from U.S. Provisional Application Nos. 60/166,348 filed on 19 November 1999, 60/171,437 filed on 22 December 1999, and 60/171,467 filed on 22 December 1999.

BACKGROUND

People rely on disposable absorbent articles to help participate in and enjoy their daily activities.

Disposable absorbent articles, including adult incontinence articles and diapers, are generally manufactured by combining several components. These components typically include a liquid-permeable topsheet; a liquid-impermeable backsheet attached to the topsheet; and an absorbent core located between the topsheet and the backsheet. When the disposable article is worn, the liquid-permeable topsheet is positioned next to the body of the wearer. The topsheet allows passage of bodily fluids into the absorbent core. The liquid-impermeable backsheet helps prevent leakage of fluids held in the absorbent core. The absorbent core is designed to have desirable physical properties, e.g. a high absorbent capacity and high absorption rate, so that bodily fluids can be transported from the skin of the wearer into the disposable absorbent article.

Some disposable absorbent articles are constructed with various types of elasticized waistbands and elasticized leg bands or leg cuffs. One method of constructing elasticized regions is to incorporate elastic strands into the disposable absorbent product. For example, elastic strands have been laminated between layers of polymer film and/or layers of woven or nonwoven fabrics to provide such regions. Folded-over layers have also been employed to enclose or envelop selected strands of material. These folded-over layers have been employed to enclose elastomeric strands within the waistband, leg cuff and inner barrier cuff components of disposable diapers and other disposable absorbent articles. The polymeric film or films, layers of woven or nonwoven fabrics, and/or folded-over layers may be an integral portion of the topsheet and/or backsheet discussed above, or may be separate components that are attached to the topsheet and/or backsheet.

In order to introduce an elastic strand to the product being made, a spool of the strand is generally placed on an unwind stand. The strand is then continuously unwound, in the machine direction, with the strand being attached to a substrate, such as a base layer of material, to provide a substrate composite. As stated above, examples of a base material include, but are not limited to, polymeric films and/or woven or nonwoven fabrics.
Also, as stated above, the elastic strand is typically sandwiched between two different layers of base material, or between a folded-over portion of base material, to form a substrate composite. In many cases the strand is attached to the base material, or materials, using an adhesive.

To produce an elasticized region, the strand is elastomerically stretched when it is attached to a base material to form a substrate composite. The stretched elastic strands tend to retract and gather the substrate composite, thereby imparting elastomeric properties to the substrate composite. As mentioned above, the substrate composite may be formed to provide an elasticized waistband or leg band in a disposable absorbent product.

If the elastic strand or strands are not attached uniformly and with sufficient strength to the base material or materials in a substrate composite, then the elasticized region may not provide the desired elastomeric properties and, in the case of disposable absorbent articles, may not provide the desired fit for the wearer.

One way to improve the uniformity and strength of attachment is to increase the amount of adhesive that is used to attach the elastic strand to one or more base materials. This approach is not always desirable due to the cost of the adhesive.

What is needed is substrate composite incorporating an elastic strand or strands that are more uniformly and/or strongly attached to a base material or materials, and a method of making such a substrate composite.

**SUMMARY**

We have found that the uniformity and/or strength of the attachment between one or more elastic strands and a base material, or materials, in a substrate composite is improved by heating the strand. By heating the elastic strand or strands prior to attachment, creep resistance, a measure of the uniformity and strength of adhesion between elastic strand and base material, increases by about 5% or more, particularly by about 10% or more, and more particularly by about 15% or more. Thus, the present invention is directed to improving the uniformity and/or strength of the attachment of elastic strand to base material by heating the strand prior to attachment. The strand may be heated by thermal conduction and/or convection, by radiative methods incorporating, for example, infrared radiation or microwave radiation, or some combination of these. If the elastic strand is made at a location different from the location where the strand is used as a raw material, the strand may be heated at either location. Furthermore, the strand may be heated in-line, i.e. as part of the process that makes the strand or the process that
uses the strand as a raw material, or off-line, i.e. in a step separate from either of the aforesaid processes.

One method having features of the present invention comprises the steps of: providing elastic strand; heating the strand; positioning the strand so that it will lie between a first base material and a second base material; applying an adhesive to the strand, the first base material, the second base material, or some combination thereof so that at least a portion of the strand is attached to at least a portion of the first base material and at least a portion of the second base material; wherein heating the strand increases the creep-resistance value of the substrate composite by about 5% or more, particularly about 10% or more, specifically about 15% or more, compared to the creep-resistance value of a substrate composite prepared using the same materials and in the same way, except that the strand is not heated.

In some versions of the invention the first base material and the second base material are one and the same material with the strand positioned between and attached to one or both interior surfaces of a folded-over portion of the material.

In some representative embodiments of the invention the elastic strand comprises polyester, polyurethane, polyether, polyamide, polycarbonate, polyester-b-polyurethane block copolymer, polyether-b-polyurethane block copolymer, or polyether-b-polyamide block copolymer. In another aspect, the strand is coated with a lubricant.

Some methods of the present invention comprise heating the strand by directing hot air, infrared radiation, or microwave radiation at the strand.

In one aspect, the strand is heated by placing a bobbin of the strand in a heated environment having an air temperature between 100°C and 200°C for 2 or more hours, and particularly about 4 or more hours.

One method having features of the present invention comprises providing elastic strand, said strand comprising a polyester-b-polyurethane block copolymer or a polyether-b-polyurethane block copolymer, the strand having been prepared by steps comprising lubricating the surface of the strand; heating the strand before the strand is attached to a base material, said heating step comprising exposing the strand to hot air, infrared radiation, microwave radiation, or a combination thereof; positioning the strand so that it will lie between a first base material and a second base material; applying an adhesive to the strand, the first base material, the second base material, or some combination thereof at an add-on rate of at least about 4 grams per square meter or greater so that at least a portion of the strand is attached to at least a portion of the first base material and at least a portion of the second base material; wherein the creep-resistance value of the substrate composite comprising heat-treated elastic strand is at least about 5% greater than the
creep-resistance value of a substrate composite comprising elastic strand that has not been heat-treated.

In another embodiment of the present invention, the elastic strand is processed by steps comprising: providing an elastic strand, the elastic strand having been made by steps comprising extruding, spinning, or otherwise making the strand; heating the elastic strand; and regulating exposure of the strand to water or water vapor (before, during, or after heating), as disclosed in a co-pending U.S. Patent Application Number 60/166348 (internal K-C Invention Disclosure Number 15427), entitled "Method for Regulating Strength Degradation in an Elastic Strand," which was filed on 19 November 1999 and from which this non-provisional application claims priority and incorporates by reference in a manner consistent herewith; and attaching the heat-treated elastic strand to at least one base material to form a substrate composite so that the substrate composite incorporating the heat-treated elastic strand possesses a creep-resistance value that is at least about 5% greater, more particularly about 10% greater, and more particularly about 15% greater than the creep-resistance value of a substrate composite incorporating elastic strand that was not heat treated. The co-pending application is generally directed to a method for regulating exposure of elastic strand to water or water vapor, thereby regulating degradation of strength characteristics of the strand due to the action of water vapor or water on the strand. Accordingly, the present invention is directed to methods encompassing both heat treating the elastic strand to increase the creep-resistance value of a substrate composite incorporating the heated elastic strand, and regulating exposure of the strand to water or water vapor to minimize or eliminate strength degradation of the strand prior to its incorporation into a substrate composite. Examples of various embodiments of combined heat-treating / water-vapor-regulating methods are detailed below in the Description section.

Examples of various methods for regulating elastic strand's exposure to water or water vapor, which may be used before, during, or after heating of elastic strand are given below.

In some embodiments, elastic strand's exposure to water vapor is regulated before, during, or after heating such that the specific humidity around the strand does not exceed about 0.01 pounds-mass of water vapor per pound-mass of dry air, specifically about 0.005 pounds-mass of water vapor per pound-mass of dry air during: production of the strand, storage of the strand at the geographic site where the elastic strand is made, shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is to be used as a raw material, storage of the elastic strand at the geographic site where the elastic strand is to be used as a raw
material, use of the elastic strand as a raw material, or some combination thereof. In one aspect, the elastic strand is used as a raw material to produce a substrate composite comprising the elastic strand or an absorbent article comprising the elastic strand.

In another aspect, the elastic strand's exposure to water vapor is regulated during shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is used as a raw material.

In some representative embodiments, regulating the strand's exposure to water vapor comprises controlling the temperature around the strand or around a container that contains the strand. For example, the temperature may be controlled to a value not exceeding about 55 degrees Fahrenheit. By regulating temperature, the maximum humidity that may be attained is regulated (i.e., as air temperature decreases, the capacity of the air to hold water vapor decreases).

In other versions of the invention, regulating the strand's exposure to water vapor comprises controlling the humidity around the strand or around a container that contains the strand.

In other versions of the invention, regulating the elastic strand's exposure to water vapor before or after heating of the strand comprises placing the strand in a container comprising a barrier material and closing the container.

In another aspect, the container comprising a barrier material is closed at a time \( t_1 \), time \( t_1 \) being after the time when the strand is first produced and before the time when the strand is shipped from the geographical site at which the strand is first produced to the geographical site at which the strand is used.

In still another aspect, the specific humidity around the strand does not exceed about 0.017 pounds-mass of water vapor per pound-mass of dry air, particularly about 0.01 pounds-mass of water vapor per pound-mass of dry air, and specifically about 0.005 pounds-mass of water vapor per pound-mass of dry air, between time \( t_1 \) and time \( t_2 \), time \( t_2 \) being the time when the closed container comprising a barrier material is first opened.

In some versions of the invention the barrier material comprises polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chloride, polyester, polycarbonate, nylon, cellulose, or a combination thereof.

In another aspect, closing the container comprising a barrier material comprises heat sealing the container, the barrier material, or both.

Some representative embodiments involve placing desiccant material with the strand before heat sealing the container, the barrier material, or both. Possible desiccant
materials comprise calcium chloride, calcium sulfate, silica gel, a molecular sieve, Al₂O₃, or some combination of thereof.

In other versions of the invention, any mixture of air and water vapor inside the container comprising a barrier material is displaced with an inert dry gas before heat sealing the container, the barrier material, or both; placing a humidity indicator inside the container comprising a barrier material before heat sealing the container, the barrier material, or both; or both of these steps.

The invention encompasses elastic strand that is heated to improve creep resistance of a substrate composite, as well as substrate composites and/or disposable absorbent products comprising said strand. Furthermore, as mentioned above, the elastic strand may also be handled such that the strand's exposure to water or water vapor is regulated before, during, or after heat treatment of the strand.

These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings.

**DRAWINGS**

Figure 1 shows a sectional view of one apparatus for making an elastic strand.

Figure 2 shows a sectional view of one apparatus for making an elastic strand.

Figure 3 give sequential views of a substrate composite as it undergoes one version of a test for creep.

Figure 4 shows a side view of one process for attaching one or more elastic strands to at least one base material.

**DESCRIPTION**

The present invention is directed to improving adhesion between elastic strand and base material in a substrate composite. Generally, a method of the present invention involves heating the strand with heated air; some type of radiation, for example microwave radiation or infrared radiation; or some combination of these. If the strand is made at a location different from the location where the strand is being used as a raw material, the elastic strand may be heated at the location where it is made, at the location where it is used as a raw material, or both. Furthermore, the strand may be heated in-line, i.e., as part of either the process for making the strand or the process in which the strand is used as a raw material, or off-line, i.e., as a step separate from either of these processes. One method having features of the present invention includes the steps of: providing an elastic strand, the elastic strand having been made by steps comprising extruding, spinning, or otherwise making the strand; heating the strand; and attaching the strand to at least one
base material to form a substrate composite so that the substrate composite incorporating the heated elastic strand possesses a creep-resistance value that is at least about 5% greater, more particularly about 10% greater, and more particularly about 15% greater than the creep-resistance value of a substrate composite incorporating elastic strand that was not heated. These and other embodiments of the present invention, including embodiments directed to substrate composites and disposable absorbent products, are discussed in more detail in the following paragraphs.

An elastic strand may be made in various ways, including, but not limited to extrusion and spinning. In an extrusion process, depicted in Figure 1, polymer chips, particulates, pellets, or other solid forms 10 are placed in a hopper 12. The solid polymer is directed from the hopper to a chamber 14. The polymer is propelled continuously through the chamber by a rotating screw 16. As the polymer proceeds through the chamber, the temperature and pressure are such that the solid polymer melts and is compacted. Some of the heat is generated by friction, but typically, an external heating source 18 is also used to heat the polymer. The molten polymer is then forced through a die 20 to give a strand, continuous fiber, or filament of a desired structural shape. Possible cross-sectional shapes include, but are not limited to, circular, tri-lobal, polyhedral, rectangular (e.g., ribbon-like), or ellipsoidal shapes. The strand cools and solidifies after exiting the extruder.

Rather than use a polymer as a feed material, one or more monomers may be added to the extruder in chip, particulate, pellet or other solid form. Alternatively, a pre-polymer having a molecular weight greater than that of the monomer, but less than that of the final polymer, may be added to the extruder. The monomers or pre-polymers may be added with compounds that promote polymerization. Polymerization occurs within the extruder chamber, but may or may not be complete before the material exits through the die. If polymerization is not complete, then some polymerization could occur after the material is extruded. Also, some of the monomer or pre-polymer may not ultimately react to become a part of a polymeric chain in the strand.

A number of materials may be extruded to give an elastic strand including, but not limited to: polyester; polyurethane; polyether; polyamide; polyacrylate; or combinations thereof, including random, block, or graft copolymers such as polyester-b-polyurethane block copolymers, polyether-b-polyurethane block copolymers, and/or polyether-b-polyamide block copolymers. As stated above, monomeric or pre-polymeric precursors may be added to the extruder to give the polymeric materials of the type just recited.

The present invention may be used in conjunction with the subject matter disclosed in co-pending U.S. Patent Application Number 60/166348. When the elastic strand is
susceptible to attack by water (e.g., by hydrolysis), then degradation of the strand’s strength due to the action of water may be regulated by regulating the strand’s exposure to water or water vapor. If the elastic strand is made, stored, shipped, or otherwise processed so that the strength of the strand degrades significantly due to the action of water or water vapor, then heat treatment of the strand in accordance with the present invention may be less effective in improving creep resistance (i.e., improving the uniformity and strength of the bond between elastic strand and base material in a substrate composite). As discussed below, the strand’s exposure to water or water vapor may be regulated before the strand is heated, when the strand is heated, after the strand is heated, or some combination thereof.

Crosslinking agents may also be used when making an elastic strand. To the extent that polymeric chains are crosslinked, it is more likely that crosslinking reactions are initiated after the material is extruded. This may be accomplished, for example, in a separate processing step after the strand is extruded.

After the strand exits the extruder, it may be subjected to additional processing steps. These processing steps may take place at some location between extrusion of the strand and the strand being wound up at a bobbin, spindle, or spool for the first time. Alternatively, one or more of these processing steps may take place after the strand has been wound up for the first time. After a bobbin of elastic strand is made, it may later be unwound and treated in some fashion prior to its being wound up again.

Additional processing steps include, but are not limited to, the following. Air might be directed at the strand exiting the die to increase the cooling rate. A scouring step might be included to remove impurities from the strand by exposing the strand to soaps or detergents. A lubricant may be applied to the strand to reduce friction between strands or between the strand and pieces of equipment. Possible lubricants include, but are not limited to, a vegetable or mineral oil, a suitably refined petroleum product, a silicone-based material, or a surfactant. And a drawing step may be included to help orient the polymers to produce desirable physical properties. In one example of a separate drawing step, the strand is directed over two sets of rolls. The strand passes over a first set of rolls moving at a first velocity, then passes over a second set of rolls moving at a second velocity, the second velocity being greater than the first velocity. The difference in velocity between the first and second sets of rolls increases tension on the strand, thereby helping to orient the constituent polymers of the strand, change physical dimensions of the strand, or effect other changes.

After these or other additional processing steps, the strand is wound up for storage or shipment to another geographic location. During this or other steps in which a spool,
reel, or bobbin of an elastic strand is unwound and then wound, the strand may be treated with various additives such as cleaning agents, lubricants, or dyes.

In addition to the example of an extrusion process discussed above, various spinning processes may be used to produce an elastic strand or fiber. In general, these processes require dissolving the polymer in solution or melting the polymer.

In a melt spinning process, as depicted in Figure 2, polymer chips, particulates, pellets, or other solid forms 30 are heated by a heated-metal grid 32 or other heating device. The resulting molten polymer 34 is pumped under high pressure through a plate called a spinneret 38. The plate generally defines a plurality of small holes. The molten polymer emerges from the face of the spinneret, usually into air, and solidifies. A number of these strands 40 may be brought together to form a cable- or rope-like structure comprising a plurality of strands.

The polymer typically is melted by contacting a hot grid in the form of steel tubing, which is heated electrically, or by some other means. A metering pump 36, or a combination of a metering pump and a booster pump, may be used to conduct the molten polymer to, and through, the spinneret. Alternatively, an extrusion-type screw may be used to help melt the polymer, and meter the resulting molten polymer, to and through the spinneret.

Generally strands or filaments emerge from the spinneret face into air and begin to cool. Air jets or blasts directed at the emerging strands may be used to speed up the cooling process. After the strands or filaments have traveled far enough to solidify they are processed further. As stated above, additional process steps include, but are not limited to, scouring, lubricating, or drawing the strand or strands. Figure 2, for example, depicts a lubricating disk and trough 42 for applying a lubricant to one or more strands.

After processing is complete the strand—in this case a cable- or rope-like structure—is wound up on a reel, spindle, spool, or bobbin 44 at a winding station. Before being wound up, the strand may pass over one or more rolls 46.

Other spinning processes include wet spinning, in which a solution of a polymer or polymer derivative emerges from a spinneret into a liquid that coagulates the polymer or polymer derivative to form a strand; and dry spinning in which a solution of polymer emerges from the spinneret into air or an inert gas atmosphere into which solvent evaporates, thereby forming a filament or strand. Examples of such methods are given in FRED W. BILLMEYER, JR., TEXTBOOK OF POLYMER SCIENCE, pp. 518-530 (Wiley-Interscience, 2d ed. 1971).

Generally, the same polymeric, pre-polymeric, or monomeric materials useful for extruding an elastic strand are also useful for spinning an elastic strand. Examples of
such materials are discussed above. Also, crosslinking agents may be used. Again

crosslinking will likely be effected after the strand or filament emerges from the spinneret.

It should be understood that the above discussion gives exemplars of ways of
making elastic strand. The present invention is not limited to these exemplars, but may be
used in conjunction with other processes for making an elastic strand.

Before referring to data demonstrating that heating an elastic strand improves the
creep-resistance value of a substrate composite incorporating the heated strand, it is
advantageous to discuss certain terms. For purposes of this application, "creep-
resistance" or "creep-resistance value" refers to the elastic-strand holding power of a
particular system for attaching one or more elastic strands to at least one base material.
For example, if an adhesive is applied in liquid form to a base material, and an elastic
strand or strands are then pressed against the adhesive and base material to attach the
strand or strands to the base material, then creep resistance is a measure of the quality of
the adhesive bond between the strand or strands and the base material.

An explanation of a test for measuring creep provides additional detail regarding
this concept. As discussed below, substrate composites were formed by sandwiching a
plurality of elastic strands between two base materials to form a substrate composite or
laminate. As depicted in Figure 3, a sample 60 having a width of 60 millimeters and a
length of 250 millimeters was cut from a continuous web of the substrate composite. The
substrate composite incorporated 10 elastic strands 62 (not all strands are depicted)
located approximately 5 millimeters from one another across the width of the substrate
composite. To conduct the test for measuring creep, the sample was first fully extended
by hanging the sample vertically in front of an illuminated light box. The top of the sample
was clamped to the light box and a 1000-gram weight was clamped to the bottom of the
sample (the arrow 64 denotes the effect of the weight). In this fully extended form, a
template was used to mark the substrate near the opposing ends to denote a
200 millimeter length 66 (sample material beyond the 200 mm length is not depicted).

The weight was then removed and the sample was placed horizontally on a piece
of cardboard. The substrate composite 68 was allowed to contract so that the marks on
the substrate composite were now 175 millimeters apart 70 (again, sample material
beyond the 175 mm length is not depicted). The sample was then stapled to the
cardboard, with the staples (not shown) located outside the 175 mm length. The lines
parallel to the length dimension of the sample in this partially retracted form, i.e. 175 mm,
represent the elastic strands 62 (not all strands are depicted), with the exception of the
outermost lines, which represent the edges of the substrate composite. The lines that are
perpendicular to the length dimension of the substrate composite represent gathers of
base material caused by the elastomeric strands retracting after the weight was removed (except for the outermost lines that are perpendicular to the length dimension, which again represent marks on the substrate composite that are 175 mm apart). When the elastic strands retract, they gather base material so that the substrate composite itself has elastomeric qualities.

The elastic strands were then cut at the marks 72 and 74 denoting the length of 175 mm. Because the strands were located between two base materials, typically one of the base materials was partially or completely slit when the strands were cut. After the elastic strands 62 were cut, they generally retracted. About 1-2 minutes after the strands were cut, the length of the retracted strands was measured. The difference between 175 mm and the initial retracted strand length 78, or $I_{\text{initial}}$, was used to calculate the “initial creep” of the sample. For the present application, initial creep is calculated using the following equation:

$$\text{Initial Creep, in percent} = \left[ \frac{(175 \text{ mm} - I_{\text{initial}} \text{ mm})}{175 \text{ mm}} \right] \times 100 \quad [\text{Eq. 1}]$$

After initial creep of the sample was determined, the substrate composite 76—still stapled to the cardboard—was placed in a forced-air oven pre-heated to a temperature of 100°F. After 90 minutes, the substrate composite and cardboard were removed from the oven. The substrate composite was then allowed to cool for approximately 10 minutes. The length of the strands, which now had retracted still more, was measured.

The difference between 175 mm and the final retracted length, or $Y_{\text{final}}$, was used to calculate the “final creep” of the sample. For the present application, final creep is calculated using the following equation:

$$\text{Final Creep, in percent} = \left[ \frac{(175 \text{ mm} - Y_{\text{final}} \text{ mm})}{175 \text{ mm}} \right] \times 100 \quad [\text{Eq. 2}]$$

Creep resistance, or the creep-resistance value, for purposes of the present application, is calculated as follows:

$$\text{Creep Resistance, in percent} = 100 - \text{Final Creep} \quad [\text{Eq. 3}]$$

For disposable absorbent articles that are worn near the body of the wearer, final creep provides a measure of performance of the article during use, since the human body temperature is about 98°F. Hypothetical situations provide more detail on the meaning of this measurement. Assume that a substrate composite is made in which three elastic...
strands are sandwiched between two base materials or one folded-over base material. Also assume that the laminate is made by attaching the strands to a base material using an adhesive while the strands are in elongated form, typically at an elongation from about 200% to about 300% (see Examples below and U.S. Patent No. 5,964,973, entitled “Method and Apparatus for Making an Elastomeric Laminate Web,” which is hereby incorporated by reference in a manner consistent with the present specification, for more detail on how a substrate composite incorporating elastic strand is made). If, after aging at 100°F for 90 minutes, the elastic strands detach from the adhesive and base material along most of the length of each strand, and the strands retract, then final creep will be relatively high and creep resistance will be relatively low. Performance of the substrate composite as an elastomeric composite will likely be poor because the detached strands, now retracted and embodying less tension, are less likely to gather the base material or materials in a relatively uniform fashion along the length of the substrate composite, if at all.

In a second hypothetical situation, assume again that a substrate composite is made as described in the preceding paragraph. Assume also that the strands are attached to the base material or materials using an adhesive. If, after aging at 100°F for 90 minutes, the elastic strands remain uniformly attached to the base material along most of the length of each strand, then final creep will be relatively low and creep resistance will be relatively high. Performance of the substrate composite as an elastomeric composite will likely be good because the strands will retract and gather the base material or materials in a relatively uniform fashion along the length of the substrate composite.

The Examples below demonstrate that heating elastic strand reduces the final-creep value, i.e., improves creep resistance, of substrate composites incorporating heated elastic strand. Table 1, for example, shows that a final-creep value of 22.9% was achieved for heat-treated GLOSPAN 840 elastic strands sandwiched between two spunbond webs when a meltblown application technique was used to apply H-2525A adhesive at an add-on level of 7 grams per square meter (i.e., g m⁻²). The strands of GLOSPAN 840 were attached to the spunbond webs while at an elongation of 200%.

GLOSPAN 840 is an elastic-strand material made by Globe Manufacturing Company of Fall River, Massachusetts, and comprises a polyester-b-polyurethane block copolymer. Typically the spunbond webs comprised polypropylene fibers and had a basis weight of 0.5 ounces per square yard. A control substrate composite, however, required an H-2525A adhesive add-on level of 10 g m⁻² to achieve the same final-creep value of 22.9%.

Thus heat-treating GLOSPAN 840 elastic strand decreased the amount of adhesive needed to achieve a given final-creep value.
The preceding example shows that the creep-resistance value of a substrate composite may be improved by heating the strand before it is attached to base material. As stated above, elastic strand may be heated by hot air—*i.e.*, by convective heat transport and thermal conduction, by microwave radiation, by infrared radiation, or by some combination thereof. If the elastic strand, or bobbins of elastic strand, are heated in a separate process step (*i.e.*, off-line), then the strand or bobbins may be heated in a forced-air oven, a microwave oven, or under infrared lamps. If, on the other hand, the strand is heated as part of a process for making the strand or using the strand as a raw material (*i.e.*, in-line), then microwave radiation, infrared radiation, hot air, or some combination of these may be directed at the moving strand to heat the strand.

If an oven is the only device used to heat the strand, then the strand will typically be heated in a step separate from a process used to make the strand, or a process that uses the elastic strand as a raw material. While the oven temperature could be increased above 100 °C to increase the rate at which the strand is heated, the temperature cannot be raised so high that the polymeric constituents of the strand degrade. It should be noted, however, that a method relying on convection and conduction to heat the strand, *e.g.* directing hot air at the strand, could be combined with one or more irradiative methods to heat the strand in-line (discussed below).

To heat the elastic strand in a step separate from a strand production process or a process that uses the strand as a raw material (*i.e.*, off-line), spools, bobbins, or reels of the strand may be placed in an oven at a selected temperature and for a selected time. Alternatively, heated air at a selected temperature may be directed at the spools, bobbins, or reels for a selected time. As discussed in a co-pending U.S. Patent Application, serial number 60/171,467, entitled "Method for Improving Strength Characteristics of Elastic Strand," which was filed on 22 December 1999 and is hereby incorporated by reference in a manner consistent herewith (and from which this non-provisional application claims priority), analytical techniques may be used to ascertain whether an elastic strand material degrades at specified temperatures (*see* Examples below).

Spools or bobbins of the strand may be placed in an oven either at the location where the elastic strand is made or at the location where the elastic strand is used as a raw material (*if* the location where the strand is used is different from the location where the strand is produced). For example, bobbins of elastic strand, after the strand is first wound up at the site where the strand is made, could be placed in a forced-air oven at a temperature of 102°C or more for 2 or more hours. Alternatively, the strand could be placed in a forced-air oven at higher temperatures for shorter period of time. After the
strand was heat treated, the bobbins could be prepared for shipment, or could be stored for some period of time prior to shipment.

Other approaches can be used to heat the strand. For example, an infrared light could be placed in close proximity to an elastic strand in order to irradiate the strand. One example of an infrared light is a 250W infrared lamp available from TechniLab Instruments, Inc., of Requannock, New Jersey. Absorption of infrared radiation by the polymeric constituents of the strand would generate heat, thereby heating the strand. Furthermore, an infrared light, or a plurality of lights, can be located in close proximity to the strand after it has been extruded or spun, but before it is wound up on a bobbin for the first time (i.e., in-line at the site where the elastic strand is made). If there is a separate processing step in which a bobbin is unwound, treated, and then wound up again, then an infrared light, or plurality of infrared lights, could be used to heat-treat the strand during a separate processing step.

Alternatively, the elastic strand can be irradiated with microwave radiation to heat the strand. A suitable microwave generator and cavity is described in U.S. Patent Number 5,536,921, issued 16 July 1996 to Hedrick et al., which is hereby incorporated by reference. This device, useful for on-line treatment of sheet-like materials, may also be used for in-line treatment of elastic strand. The device comprises a cylindrical single-mode resonating-cavity microwave applicator (Model TM101), and is available from International Business Machines Corporation, a business having offices at Armonk, New York. The diameter of the applicator of this model is 4 inches, and the output power can be adjusted continuously up to 6.0 kW at a frequency of 2450 MHz. The elastic strand can be directed through the cavity so that the strand is exposed to a plurality of microwave standing waves within the cavity. As the elastic material passes through the standing waves the incident microwave energy is converted into heat within the strand. An example of using a microwave generator to continuously treat a web, rather than a strand, is given in U.S. Patent Number 5,916,203, which is hereby incorporated by reference in a manner consistent herewith. This same approach can be used to heat an elastic strand, or a plurality of elastic strands.

One or more of the above-identified methods may be used in combination to heat an elastic strand, or plurality of elastic strands. For example, an infrared light, or several infrared lights, could be used in combination with streams of hot air directed at a strand to heat the strand. Or streams of hot air could be directed at the strand before or after the strand was exposed to microwave radiation in a cavity as discussed above. Any combination of ways in which energy is transmitted to the elastic strand so that the strand is heated, thereby improving the creep resistance (or decreasing the final-creep value) of
a substrate composite incorporating the heated strand, is encompassed by the present invention.

As discussed in co-pending U.S. Patent Application Number 60/166348, in some instances bobbins of elastic strand, after being first wound up, may be processed or treated in some fashion by unwinding the bobbin, treating the strand, and then winding the strand up once more. This co-pending application also discloses that an elastic strand's exposure to water vapor can be regulated in order to regulate strength degradation in the strand. Thus an elastic strand that is heat treated by the manufacturer of the strand can also be processed, stored, handled, or shipped in a manner that regulates exposure of the heat-treated strand to water vapor.

Co-pending U.S. Patent Application Number 60/166348 gives a number of examples by which an elastic strand's exposure to water vapor can be regulated. These same methods may be used with elastic strand before it is heat treated, after it is heat treated, or both before and after the strand is heat-treated. If the elastic strand has already been heat treated, then bobbins, spools, or reels of the heat-treated strand may be stored in a controlled-humidity or controlled-temperature room or facility. If these bobbins are shipped to another location, then these bobbins can be packaged in a container comprising a barrier material resistant to the penetration of water vapor. If the elastic strand is placed in a container comprising a barrier material while in a low-humidity environment, then the micro-environment immediately around the elastic strand inside the container will correspond to that low-humidity environment. After the container is closed (e.g. heat sealing a plastic bag), subsequent processing steps can be carried out so that the humidity or temperature outside the container is not regulated. The container would likely not be opened until the elastic strand was to be used as a raw material in a production process.

As disclosed in co-pending U.S. patent application number 60/166348, a desiccant material may be placed near the elastic strand—including elastic strand that has been heat treated—before closing the container comprising a barrier material. To the extent that the container allows water vapor to penetrate into and around the elastic strand, the desiccant acts to preferentially adsorb or absorb the water vapor. Accordingly, the desiccant helps to keep the humidity inside the container at a level that minimizes strength degradation.

In another aspect, a humidity detector or indicator is placed with the elastic strand—again the elastic strand may already have been heat-treated—before the container comprising a barrier material is closed. When the bag or container is opened, most likely after it has been shipped to a purchaser of the elastic strand, the humidity
detector can be examined to determine if the humidity inside the container exceeded a certain value. If the humidity did exceed a certain value, then the bag or container could be rejected and sent back to the supplier. Alternatively, a sample from the shipment could be tested immediately. If the strength characteristics of the strand were deemed acceptable, then the shipment could be accepted for use as a raw material.

Rather than heat the strand at the site where the strand is made, bobbins of the elastic strand can be heated at the site where the strand is used as a raw material. If the elastic strand is not shipped in a sealed container comprising a barrier material, then the elastic strand could be heated when it is received, or after any storage time but prior to the strand being used as a raw material. If the elastic strand is stored prior to use, the strand could be stored in a controlled-temperature or controlled-humidity environment as disclosed in co-pending U.S. Patent Application Number 60/166348.

If the elastic strand were shipped in a container comprising a barrier material, then the elastic strand would likely not be heated until the container is opened. Thus, for example, the containers of elastic strand could be stored for a period of time prior to the containers being opened. After the container is opened and bobbins of the elastic strand are removed, the bobbins could be placed in an oven for a selected temperature and time. Alternatively, the bobbins may be placed in a microwave oven to obtain the desired increase in creep resistance. Rather than heat treat the strand off-line, the elastic strand could be irradiated with microwave radiation, infrared radiation, and/or hot air at some location between the unwind stand and the strand's point of attachment on a base material to make a substrate composite (i.e., in-line). In each case, data may be used to select the heat-treatment conditions necessary to achieve a given improvement in creep resistance (e.g., the Examples below demonstrate that heat-treatment conditions for achieving a given change in final creep—or creep resistance—may be ascertained).

Additional Detail on Regulating Strength Degradation in Elastic Strand

As discussed above, methods for improving the creep resistance of a substrate composite may be combined with methods for regulating strength degradation in elastic strand by regulating the strand's exposure to water or water vapor. Before proceeding to a more detailed discussion of some representative ways in which a strand's exposure to water or water vapor may be regulated, it is useful to review certain additional definitions. The term specific humidity generally refers to the mass of vapor carried by a unit mass of vapor-free gas. As used herein, "specific humidity" refers to the mass of water vapor carried by a unit mass of vapor-free gas, the gas typically being air. The term relative humidity generally refers to the ratio of the partial pressure of the vapor to the vapor pressure of the liquid at the gas temperature. It is usually expressed on a percentage
basis, so 100 percent relative humidity means that the gas is saturated with vapor and 0 percent relative humidity means that the gas is vapor free. As used herein, “relative humidity” refers to the ratio of the partial pressure of water vapor to the vapor pressure of water at the gas temperature, the gas typically being air. For purposes of this document, “humidity” refers to a measure of the amount of water vapor in a gas, typically air, and unless stated otherwise, refers to specific humidity and/or relative humidity. The term dew point generally refers to the temperature at which a vapor-gas mixture must be cooled—at constant humidity—to become saturated. As used herein, “dew point” refers to the temperature at which a water vapor-gas mixture must be cooled—at constant humidity—to become saturated, the gas generally being air.

One way in which a strand’s exposure to water vapor may be regulated is to conduct one or more of the processing and/or handling steps following extrusion or spinning in a controlled-humidity environment. This is generally accomplished by carrying out one or more of said steps in a room, compartment, or other enclosure in which a value corresponding to the humidity in the enclosure is controlled so that it does not exceed a selected set point. The set point corresponds to a desired specific humidity or relative humidity. Control generally comprises first sensing or measuring a value corresponding to the specific humidity or relative humidity in the enclosure. Typically the device used to sense or measure humidity will be in the vicinity of the elastic strand. The sensed or measured value is transmitted to a controller, computer, or other device that compares the sensed or measured value to a set-point value. If the sensed or measured value is sufficiently different from the set-point value, then a control action is taken such that the specific humidity or relative humidity in the enclosure is force adjusted to be at or below the desired specific humidity or relative humidity.

Typically, the specific humidity or relative humidity is force adjusted by directing the air/water-vapor mixture across cooling coils so that the temperature of the mixture is reduced below the mixture’s dew point. As a result of this cooling process, a portion of the water vapor condenses on the coils and is removed as liquid, thereby reducing humidity. By directing a sufficient amount of the air/water-vapor mixture across the cooling coils, and then conducting the dehumidified air into the enclosure, humidity is force adjusted to the desired level. After water vapor has been condensed and removed by this cooling process, the air may be heated to increase the dry-bulb temperature. As used herein, “dry-bulb temperature” refers to the temperature of the air/water-vapor mixture as indicated by a thermometer placed in the mixture. Accordingly, as used herein, “controlled-humidity” refers to environments in which specific humidity and/or relative humidity are controlled, and, if the air is heated to increase the dry-bulb temperature after
the air/water vapor mixture is dehumidified, environments in which the dry-bulb
temperature is also controlled or regulated.

The air/water vapor mixture may be taken from inside the enclosure, dehumidified,
and then recirculated back to the enclosure; or it may be taken from outside the enclosure,
dehumidified, and brought into the enclosure; or both. For example, if an enclosure is built
around a winding station to which an elastic strand is continuously directed, there will be
an opening in the enclosure to allow the strand to enter and be wound up. If the
manufacturing environment is hot and humid, then a slight positive pressure will likely be
maintained inside the enclosure to reduce the amount of hot, humid air entering the
enclosure through the opening. In this case, some quantity of the air/water vapor mixture
outside the enclosure will have to be dehumidified and brought into the enclosure to
replace the air/water vapor mixture inside the enclosure that is escaping through the
opening because of the positive pressure.

Rather than control humidity so that it is at or below a set-point value, the air inside
the room or enclosure can be cooled to a temperature set point such that the maximum
specific humidity cannot exceed a certain level. Humidity charts for air at atmospheric
pressure may be used to select the appropriate temperature set point. For example, at a
temperature of 40°F, even at a relative humidity of 100%, the specific humidity is about
0.006 lb\textsubscript{m} of water vapor per lb\textsubscript{m} of dry air. This value is less than \(\frac{1}{4}\) of the specific
humidity that resulted in a 60% drop in peak-load value over a 60 day period (see
Examples below). Accordingly, as used herein, "controlled-temperature" refers to
environments in which temperature is controlled to some value in order to regulate the
amount of water vapor experienced by the elastic strand.

As stated above, one embodiment of the invention is directed to controlling the
humidity of one or more of the processing and/or handling steps following extrusion or
spinning. Alternatively, the temperature of the processing and/or handling step(s) may be
controlled to limit the capacity of the air to hold water vapor. For example, the step in
which the elastic strand is first wound up at a winder may be carried out in a controlled-
humidity or controlled-temperature environment. Processing steps upstream or
downstream of the first winder may also be carried out in a controlled-humidity or
controlled-temperature environment. As used herein, "first winder" refers to the winder at
which the strand is first wound up after it is extruded or spun; "upstream" refers to those
processing steps that occur after the strand is extruded or spun, but before the first
winder; and "downstream" refers to those processing steps that occur after the first winder.

If one or more additional processing steps occur after the first winding step at a separate
unwinding/winding station (\textit{i.e.,} a station where the elastic strand is unwound, processed
in some way, and rewound), these one or more additional processing steps may be carried out in a controlled-humidity or controlled-temperature environment. To the extent that bobbins of elastic strand are stored prior to use or shipment, the bobbins may be stored in a controlled-humidity or controlled-temperature environment. If elastic strand is being shipped to another location, the step in which the elastic strand is prepared—perhaps involving another step in which the elastic strand is unwound and then wound back up again—and packaged for shipment may also be carried out in a controlled-humidity or controlled-temperature environment. And the step of shipping or transporting the elastic strand itself may be carried out in a controlled-humidity or controlled-temperature environment.

All of these steps—winding, storing, preparing and packaging for shipment (if shipping is necessary), shipping, and perhaps storing again at the location where the strand will be used as a raw material—can be carried out in a controlled-humidity or controlled-temperature environment such that the tensile strength of the strand at the time it is used as a raw material on a production machine has not decreased by more than about 20%, particularly about 10%, and specifically about 5% from the tensile strength of the strand at the time it was first produced or prepared for shipment.

In some cases, however, not all of the steps need be carried out in a controlled-humidity or controlled-temperature environment. For example, the elastic strand can be placed in a container comprising a barrier material. As used herein, “barrier material” refers to a material that is resistant to penetration by water vapor. The step of placing elastic strand in a container comprising a barrier material, i.e. packaging the elastic strand for storage or shipment, may be accomplished in a number of ways. Bobbins of elastic strand, or pallets of bobbins of elastic strand, can be wrapped or encased by a barrier material, e.g. a suitable shrink-wrap. Alternatively, bobbins of elastic strand, or pallets of bobbins of elastic strand, may be placed in a flexible plastic bag comprising a barrier material. Or the elastic strand may be placed in a box or carton comprising a barrier material, e.g. lined with or holding a flexible plastic bag that is resistant to penetration by water vapor. Other types of containers comprising a barrier material may be used.

If the elastic strand is placed in a container comprising a barrier material while in a low-humidity environment, then the micro-environment immediately around the elastic strand inside the container will correspond to that low-humidity environment. Subsequent processing steps might be carried out such that the humidity or temperature outside the container is not regulated. The container would likely not be opened until the elastic strand was to be used as a raw material in a production process.
A number of methods may be used to package the elastic strand. The elastic strand may be wound up at a first winder in a controlled-humidity or controlled-temperature environment, and then taken, conducted, or conveyed to a controlled-humidity or controlled-temperature environment for packaging. Alternatively, the elastic strand may be wound up at a first winder and, soon thereafter, taken, conducted, or conveyed to a controlled-humidity or controlled-temperature environment for packaging.

While in a controlled-humidity or controlled-temperature environment, bobbins of elastic strand, or pallets of bobbins of elastic strand are placed in a container comprising a barrier material. Suitable barrier materials that are resistant to penetration by water vapor include, but are not limited to, polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chloride, polyester, polycarbonate, nylon, cellulose, or some combination thereof. The container is then closed in a way that minimizes the amount of water vapor that might reach the packaged strand during subsequent storage and/or shipping steps. For example, if the container comprising a barrier material is a flexible polyethylene bag or other flexible, water-vapor-resistant plastic bag, then the container can be heat sealed after bobbins of elastic strand, or pallets of bobbins of elastic strand, are inserted into the bag. Alternatively, bobbins of elastic strand, or pallets of bobbins of elastic strand, can be placed in a carton or box lined with a barrier material such as a polyethylene bag, the bag being heat sealed after the bobbins of elastic strand are in place.

Desiccant material may be placed near the elastic strand prior to the container comprising a barrier material being closed, e.g. heat sealed. To the extent that the container allows water vapor to penetrate into and around the elastic strand, the desiccant acts to preferentially adsorb or absorb the water vapor. Accordingly, the desiccant helps to keep the humidity inside the container at a level that minimizes strength degradation.

Examples of useful desiccants include calcium chloride, calcium sulfate, silica gel, a molecular sieve, Al₂O₃, or some combination of thereof. Typically, the desiccant will be put in a receptacle that allows passage of water vapor into the interior of the receptacle and in contact with the desiccant, but keeps the desiccant separate from the elastic strand. An example of a receptacle is a pouch comprising a fibrous web of naturally-occurring fibers—typically having cellulose as a primary constituent—or a nonwoven material such as a polyethylene or polypropylene nonwoven fabric that that is made to allow passage of water vapor.

In another aspect, the present invention further comprises the step of displacing the air/water vapor mixture inside the container comprising a barrier material with a dry, inert gas before closing the container. For example, after pallets of bobbins of elastic strand have been placed inside a container, dry nitrogen gas may be directed to the
interior of the container using a flexible conduit. After sufficient time has passed to allow displacement of the air/water-vapor mixture from inside the container, the conduit is removed from the container, and the container is then closed. This displacement step may be used in conjunction with the step of placing a desiccant material with the elastic strand prior to closing the container. In an alternative method, the packaging system may be configured so that any air/water-vapor mixture inside the container comprising a barrier material is evacuated prior to the container being closed.

In another aspect, a humidity detector is placed with the elastic strand before the container comprising a barrier material is closed. When the bag or container is opened, most likely after it has been shipped to a purchaser of the elastic strand, the humidity detector can be examined to determine if the humidity inside the container exceeded a certain value. If the humidity did exceed a certain value, then the bag or container could be rejected and sent back to the supplier. Alternatively, a sample from the shipment could be tested immediately. If the strength characteristics of the strand were deemed acceptable, then the shipment could be accepted for use as a raw material. One example of a suitable humidity detector is the humidity indicator corresponding to catalogue number HC-10/60-200, available from Omega Engineering Inc., of Stamford, Connecticut. The indicator is capable of detecting relative humidity over the range 10 to 60 percent.

The step of placing a humidity detector with the elastic strand may be used in conjunction with: placing a desiccant with the strand before a container comprising a barrier material is closed; displacing the air/water-vapor mixture inside the container comprising a barrier material with a dry, inert gas before closing the container; or both.

In some embodiments of the present invention, bobbins of elastic strand are stored either at the site where the strand is made, at the site where the strand is used as a raw material, or both. If the strand is not packaged during these storage steps, and the strand is to be stored for more than 10, specifically more than 20, and particularly more than 30 days, then the room, facility, or area in which the strand is stored may be a controlled-humidity or controlled-temperature environment if the ambient humidity is such that the strand’s strength might be significantly degraded. But, as discussed above, all of the process and handling steps subsequent to the strand being extruded or spun may be carried out in controlled-humidity or controlled-temperature environment—regardless of the total time between extrusion or spinning of the strand and use of the strand as a raw material—to minimize or eliminate strength degradation. Or the elastic strand can be packaged so that the “micro-environment” inside the container comprising a barrier material has a low water-vapor content (i.e., a low humidity), thereby allowing subsequent
processing steps to be carried out such that the environment outside the package need
not be controlled.

Elastic strands processed or handled in accordance with the present invention may
be incorporated into a number of substrate composites and disposable absorbent articles.
Examples of such substrate composites and/or disposable absorbent articles are
described in U.S. Patent Number 4,940,464, entitled "Disposable Incontinence Garment or
Training Pant," which is hereby incorporated by reference in a manner consistent with the
present application; U.S. Patent Number 5,904,675, entitled "Absorbent Article with
Improved Elastic Margins and Containment System," which is hereby incorporated by
reference in a manner consistent herewith, with column 7, lines 7 through 34 discussing
use of elastic strands with a containment flap, and column 9, line 29 through column 10,
line 36 discussing elastic members; U.S. Patent Number 5,904,672, entitled "Absorbent
Article having Improved Waist Region Dryness and Method of Manufacture," which is
hereby incorporated by reference in a manner consistent herewith, with column 11, line 39
through column 12, line 2 discussing elastic leg members; and U.S. Patent Number
5,902,297, entitled "Absorbent Article Having a Collection Conduit," which is hereby
incorporated by reference in a manner consistent with the present application, with column
4, lines 18 through 48 discussing elasticized leg and waist members. It should be
understood that the present invention is applicable to other structures, composites, or
products incorporating one or more elastic strands that are heat-treated to improve creep
resistance (or reduce final creep), whose exposure to water or water vapor has been
regulated to regulate strength degradation, or both.

An example of a method and apparatus for making an elastomeric laminate web
(i.e., for purposes of the present application, a substrate composite incorporating elastic
strand) which may be used with the present invention is found in U.S. Patent Number
5,964,973, entitled "Method and Apparatus for Making an Elastomeric Laminate Web,"
which, as stated above, is hereby incorporated by reference in a manner consistent with
the present specification. Again it should be understood that this patent gives exemplars
of methods and apparatuses for incorporating elastic strands into substrate composites,
and the present invention of heat-treating elastic strand to improve the uniformity and
strength of attachment between elastic strand and base material may be used with other
methods and apparatuses used to make substrate composites.
EXAMPLES

Example 1

Bobbins of GLOSPAN 840 (Globe), an elastic strand comprising a polyester-b-polyurethane block copolymer, were obtained from Globe Manufacturing Company. The bobbins of GLOSPAN 840 had plastic cores with a 3-inch radius and a 10-inch length. The GLOSPAN 840 elastic strand was wound around each plastic core such that outer surface formed by the strand extended radially outwardly from the outer surface of the plastic core approximately 3 inches. For this particular experiment, the strand had been manufactured within 2 weeks of our receiving the bobbins from Globe Manufacturing Company. Furthermore, the elastic strand had been coated with a silicone-based lubricant. Bobbins were placed in a plastic bag, which was then sealed. The bag containing the bobbins was placed in a forced-air oven, model number OV-490A-2, made by Blue M, a business having offices at Blum Island, Illinois. The oven was preheated to a temperature of 102°C prior to the plastic bag being placed in the oven. After 4 hours of exposure to this selected temperature, the bag containing the bobbins of GLOSPAN 840 was removed from the oven.

Generally about 24 hours elapsed between the time the bobbins were withdrawn from the oven and the time the bobbins were mounted on unwind stands for making various substrate composites. Substrate composites were made on equipment available from J & M Laboratories, a business having offices located in Dawsonville, Georgia. Each of the bobbins was placed on an unwind stand. As depicted in Figure 4, individual strands from the bobbins were directed to a nip 106 between two rolls, a rubber roll 110 having a 4-inch diameter, and a steel roll 104 having a 6-inch diameter. A base material 102, in this case a nonwoven web, was directed from its corresponding unwind stand (not shown) to the surface of the steel roll and through the nip. A second nonwoven web 108 was directed from its unwind stand (not shown) to the surface of the rubber roll and through the nip. Typically, the equipment was operated at a speed of 100 feet per minute.

The elastomeric strands 100, in this case GLOSPAN 840, were directed from their corresponding unswinds stands (not shown) through a comb 112 and toward the nip so that the elastic strands would be sandwiched between the two nonwoven webs. The comb served to provide and maintain the desired cross-machine-directional distribution of the strands. The strands were positioned so that they were about 5 mm from one another across the width of the base materials, in this case nonwoven webs.

The speed of the strand unwind stands relative to the speed of the steel and rubber rolls was such that the strand was elongated about 200% when it was attached to the nonwoven webs using an applied adhesive. The applied adhesive was a hot-melt
adhesive, in this case an adhesive available under the alpha-numeric designator H-2525A from Ato Findley, a business having offices located in Wauwatosa, Wisconsin. The adhesive was applied at three different levels of addition, 4 grams per square meter (i.e., g m\(^{-2}\)), 7 g m\(^{-2}\), and 10 g m\(^{-2}\). For each of these three levels of addition, the adhesive was applied using one of two air-depositing techniques: either a swirling application method or a meltblowing application method.

Regardless of the level of addition or air-depositing technique used, the applicator used to deposit the adhesive was positioned so that the face of the depicted nozzle—which was roughly parallel to the surface of the web to which adhesive was first applied—was 1.5 inches from the surface of the web. Furthermore, the central axis of the depicted nozzle, which is perpendicular to the web to which adhesive is first applied, was 8 inches from a parallel axis that passes through the nip defined by the rubber and steel rolls.

The table on the following page gives the results of a number of experiments in which final creep was determined for a number of substrate composites as a function of the following variables: (1) air-depositing technique used to apply the H-2525A adhesive (swirl application or meltblown application); (2) level of addition of the H-2525A adhesive (4 g m\(^{-2}\), 7 g m\(^{-2}\), or 10 g m\(^{-2}\)); (3) the types of base materials that the elastic strand was sandwiched between (between two spunbond webs serving as the two base materials, each spunbond web having a basis weight of 0.5 ounces per square yard and comprising polypropylene fiber; or between two 3-layer laminate base materials, each laminate comprising a spunbond-meltblown-spunbond material, with the total laminate having a basis weight of about 0.6 ounces per square yard, and each of the three layers in the laminates—whether spunbond or meltblown—comprising polypropylene fiber); and (4) whether or not the elastic strand was heated using the procedure discussed above before the strand was attached to a base material to provide a substrate composite.

The results (see Table 1) show that heating GLOSPAN 840 in accordance with the present invention decreases final creep, i.e., improves creep resistance. Furthermore, heating the elastic can reduce the amount of adhesive needed to achieve a given final-creep value. For example, a final-creep value of 22.9% was achieved for heat-treated GLOSPAN 840 elastic strands sandwiched between two spunbond webs when a meltblown application technique was used to apply H-2525A adhesive at an add-on level of 7 g m\(^{-2}\). A control substrate composite incorporating GLOSPAN 840 that had not been heat treated, however, required an H-2525A adhesive add-on level of 10 g m\(^{-2}\) to achieve the same final-creep value of 22.9%.
Table 1

<table>
<thead>
<tr>
<th></th>
<th>Swirl Application</th>
<th>Meltblown Application</th>
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<tr>
<td></td>
<td>4 g m² 7 g m² 10 g m²</td>
<td>4 g m² 7 g m² 10 g m²</td>
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<tr>
<td>Spunbond / spunbond</td>
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<tr>
<td>Control</td>
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<td>36.6 28.6 22.9</td>
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<tr>
<td>Heated to 102 °C</td>
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<td>30.3 22.9 18.9</td>
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<tr>
<td>SMS / SMS</td>
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<tr>
<td>Control</td>
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<td>37.7 25.7 18.9</td>
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<tr>
<td>Heated to 102 °C</td>
<td>45.1 39.4 37.7</td>
<td>32.0 20.0 15.4</td>
</tr>
</tbody>
</table>

Example 2

Bobbins of LYCRA 940, an elastic strand comprising a polyether-b-polyurethane block copolymer, were obtained from DuPont, Inc., a business having offices located in Wilmington, Delaware. The bobbins of LYCRA 940 had plastic cores with a 3-inch radius and a 4-inch length. The LYCRA 940 elastic strand was wound around each plastic core such that outer surface formed by the strand extended radially outwardly from the outer surface of the plastic core approximately 3 inches. For this particular experiment, the strand had been manufactured within 2 weeks of our receiving the bobbins from DuPont. Each bobbin was placed in a forced-air oven, model number OV-490A-2, made by Blue M, a business having offices at Blum Island, Illinois. The oven was preheated to a temperature of 102 °C prior the bobbins being placed in the oven. After 4 hours of exposure to this selected temperature, the bobbins of LYCRA 940 were removed from the oven.

Generally about 24 hours elapsed between the time the bobbins were withdrawn from the oven and the time the bobbins were mounted on unwind stands for making various substrate composites. Substrate composites were made on equipment available from J & M Laboratories, a business having offices located in Dawsonville, Georgia. Each of the bobbins was placed on an unwind stand. As depicted in Figure 4 (refer to the previous Example for drawing numbers corresponding to identified pieces of equipment), individual strands from the bobbins were directed to a nip between two rolls, a rubber roll having a 4-inch diameter, and a steel roll having a 6-inch diameter. A base material, in this case a nonwoven web, was directed from its corresponding unwind stand (not shown) to the surface of the steel roll and through the nip. A second nonwoven was directed from
its unwind stand (not shown) to the surface of the rubber roll and through the nip. Typically, the equipment was operated at a speed of 100 feet per minute.

The elastomeric strands, in this case LYCRA 940, were directed from their corresponding unwinds stands (not shown) through a comb and toward the nip so that the elastic strands were sandwiched between the two nonwoven webs. The comb served to provide and maintain the desired cross-machine-directional distribution of the strands. The strands were positioned so that they were about 5 mm from one another across the width of the base materials, in this case nonwoven webs.

The speed of the strand unwind stands relative to the steel and rubber rolls was such that the strand was elongated about 200% when it was attached to the nonwoven webs using an applied adhesive. The applied adhesive was a hot-melt adhesive, in this case an adhesive available under the alpha-numeric designator H-2525A from Ato Findley, a business having offices located in Wauwatosa, Wisconsin. The adhesive was applied at three different levels of addition, 4 g m$^{-2}$, 7 g m$^{-2}$, and 10 g m$^{-2}$. For each of these three levels of addition, the adhesive was applied using one of two air-depositing techniques: either a swirling application method or a meltblowing application method.

Regardless of the level of addition or air-depositing technique used, the applicator used to deposit the adhesive was positioned so that the face of the depicted nozzle—which was roughly parallel to the surface of the web to which adhesive was first applied—was 1.5 inches from the surface of the web. Furthermore, the central axis of the depicted nozzle, which is perpendicular to the web to which adhesive is first applied, was 8 inches from a parallel axis that passes through the nip defined by the rubber and steel rolls.

Table 2 gives the results of a number of experiments in which final creep was determined for a number of substrate composites as a function of the following variables:

(1) air-depositing technique used to apply the H-2525A adhesive (swirl application or meltblown application); (2) level of addition of the H-2525A adhesive (4 g m$^{-2}$, 7 g m$^{-2}$, or 10 g m$^{-2}$); (3) the types of base materials that the elastic strand was sandwiched between (between two spunbond webs serving as the two base materials, each spunbond web having a basis weight of about 0.5 ounces per square yard and comprising polypropylene fiber; or between two 3-layer laminate base materials, each laminate comprising a spunbond-meltblown-spunbond material, with the total laminate having a basis weight of about 0.6 ounces per square yard, and each of the three layers in the laminates—whether spunbond or meltblown—comprising polypropylene fiber); and (4) whether or not the elastic strand was heated using the procedure discussed above before the strand was attached to a base material to provide a substrate composite.
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The results show that heating LYCRA 940 in accordance with the present invention decreases final creep, i.e., improves creep resistance. Furthermore, heating the elastic can reduce the amount of adhesive needed to achieve a given final-creep value. For example, a final-creep value of 46.3% was achieved for heat-treated LYCRA 940 elastic strands sandwiched between two spunbond webs when a swirl application technique was used to apply H-2525A adhesive at an add-on level of 4 g m². A control substrate composite incorporating LYCRA 940 that had not been heat treated, however, required an H-2525A adhesive add-on level of 7 g m² to achieve the same final-creep value of 46.3%.

**Example 3**

The thermal stability of a sample of GLOSPAN 840 was determined using thermogravimetric analysis and differential scanning calorimetry. For the thermogravimetric analysis, a sample of GLOSPAN 840 was placed in a sample holder in the heating element of a Model 951 Thermogravimetric Analyzer made by TA Instruments, a business having offices in New Castle, Delaware. The sample was heated from room temperature, which was approximately 21°C, to a temperature of 450°C at a heating rate of 10°C per minute. The sample was heated under a dynamic atmosphere of air with an airflow of approximately 80 milliliters per minute. The crucible was continuously weighed during heating so that any decrease in weight could be detected. The resulting weight-change curve, i.e. a plot of sample weight versus temperature, showed that GLOSPAN 840 had a decomposition temperature of about 240°C in air.

For the analysis using differential scanning calorimetry, a 10 milligram sample of GLOSPAN 840 was placed in the sample chamber of the heating/cooling block of a Model
2920 differential scanning calorimetry analyzer made by TA Instruments. The sample was heated from –100°C to 200°C, then cooled to –100°C, then reheated again to 200°C, at a heating and cooling rate of 10°C per minute. A Liquid Nitrogen Cooling Accessory, also made by TA Instruments, was attached to the Model 2920 differential scanning calorimeter. The results indicated that there were no significant peaks showing energy absorption or evolution over the temperature range from about 20°C to about 200°C. Thus, GLOSPAN 840 appears to be oxidatively and thermally stable over this range of temperatures.

**Example 4**

A bobbin of GLOSPAN 840 (Globe), an elastic strand comprising a polyester-b-polyurethane block copolymer, was obtained from Globe Manufacturing Company. The elastic strand had been coated with a silicone-based lubricant. Samples of the strand were placed in a controlled environment, with the temperature controlled to a value of 100°F and the relative humidity controlled to a value of 80%. At selected times of exposure to these conditions, samples of the strand were withdrawn from the controlled environment and taken to a testing room. Generally about 15 to 30 minutes elapsed between the time the sample was withdrawn from the controlled environment and the time the sample was tested.

Both the tensile strength and the elongation of a strand sample were determined using a Sinotech tensile tester, available from MTS System Corporation of Eden Prairie, Minnesota. The opposing holders on the tensile tester consisted of cylindrical rods. The gauge length was set at 1.5 inches by moving the holders such that the central axes of the rods were 1.5 inches apart. One end of a length of strand was then wrapped twice around one cylindrical rod. The other end was then taken and wrapped twice around the other cylindrical rod. The tester was then activated so that the opposing holders moved in opposite directions at a crosshead speed of 20 ± 0.4 inches min⁻¹. The strand was pulled apart at this speed until the strand broke. The peak-load value, in grams, and percent elongation, which reflects the change in length per unit length, were recorded at the point where the strand broke. This testing process was repeated at selected times of exposure to the specified conditions of relative humidity and temperature to give the tensile strength (i.e., peak-load values) as follows (each value reflects the average of 5-10 replicates: before being exposed to a temperature of 100°F and a relative humidity of 80% the peak-load value of the strand was about 375 grams (with a percent elongation of about 1080%); after exposure to these specified conditions for approximately 5 days, the peak-load value had decreased to about 345 grams (with a percent elongation of about 1175%); after exposure to these specified conditions for approximately 18 days, the peak-load value had
decreased to about 250 grams (with a percent elongation of about 1200%); after exposure
to these specified conditions for approximately 30 days, the peak-load value had
decreased to about 245 grams (with a percent elongation of about 1145%); and after
exposure to these specified conditions for approximately 65 days, the peak-load value had
decreased to about 150 grams (with a percent elongation of about 870%). This data
shows that water vapor can degrade the strength of elastic strand.

Example 5

Samples from the same bobbin of GLOSPAN 840 discussed in Example 1 were placed in
a controlled environment, with the temperature at 120°F and the relative humidity at 20%.
Using the same procedure described in Example 1, samples of the strand were tested at
selected times of exposure to these conditions to give the following (each value reflects
the average of 5-10 replicates: before being exposed to a temperature of 120°F and a
relative humidity of 20% the peak-load value of the strand was about 375 grams (with a
percent elongation of about 1080%); after exposure to these specified conditions for
approximately 50 hours, the peak-load value was about 400 grams (with a percent
elongation of about 1125%); after exposure to these specified conditions for approximately
180 hours, the peak-load value was about 455 grams (with a percent elongation of about
1250%); and after exposure to these specified conditions for approximately 500 hours, the
peak-load value was about 410 grams (with a percent elongation of about 1275%). This
data shows that regulating an elastic material's exposure to water vapor regulates the
amount of strength degradation resulting from the action of water on the strand.

Although the present invention has been described in considerable detail with
reference to certain versions, other versions are possible. The spirit and scope of the
 appended claims should not be limited to the description of specific versions contained
herein.
What is claimed is:

1. A method for improving creep resistance of a substrate composite comprising at least one elastic strand, the method comprising:
   providing elastic strand;
   heating the strand;
   positioning the strand so that it will be located between a first base material and a second base material; and
   applying an adhesive to the strand, the first base material, the second base material, or some combination thereof so that at least a portion of the strand is attached to at least a portion of the first base material and at least a portion of the second base material wherein heating the strand increases the creep-resistance value of the substrate composite by about 5% or more compared to a substrate composite prepared under substantially identical conditions except that the elastic strand is not heated.

2. The method of claim 1 wherein the creep-resistance value of the substrate composite is increased by about 10% or more.

3. The method of claim 1 wherein the creep-resistance value of the substrate composite is increased by about 15% or more.

4. The method of claim 1 wherein the first base material and the second base material are one and the same material with the strand positioned between and attached to one or both interior surfaces of a folded-over portion of the material.

5. The method of claim 1 wherein the elastic strand comprises polyester, polyurethane, polyether, polyamide, polyacrylate, polyester-b-polyurethane block copolymer, polyether-b-polyurethane block copolymer, or polyether-b-polyamide block copolymer.

6. The method of claim 5 wherein the strand is coated with a lubricant.

7. The method of claim 5 wherein the strand is heated by directing hot air, infrared radiation, or microwave radiation at the strand.
8. The method of claim 5 wherein the strand is heated by placing a bobbin of the strand in a heated environment having an air temperature between 100°C and 200°C for 2 or more hours.

9. The method of claim 5 wherein the strand is heated by placing a bobbin of the strand into a heated environment having an air temperature between 100°C and 200°C for 4 or more hours.

10. A method for improving creep resistance of a substrate composite comprising at least one elastic strand, the method comprising:

   providing an elastic strand, said strand comprising a polyester-b-polyurethane block copolymer or a polyether-b-polyurethane block copolymer, the strand having been prepared by steps comprising lubricating the surface of the strand;

   heating the strand before the strand is attached to a base material, said heating step comprising exposing the strand to hot air, infrared radiation, microwave radiation, or a combination thereof; and

   attaching the strand to a base material using an adhesive at an add-on rate of 4 grams per square meter or greater;

   wherein the creep-resistance value of the substrate composite comprising heat-treated elastic strand is at least about 5% greater than the creep-resistance value of a substrate composite comprising elastic strand that has not been heat-treated.

11. The method of claim 2 further comprising the step of regulating the elastic strand's exposure to water vapor before, during, or after heating such that the specific humidity around the strand does not exceed about 0.01 pounds-mass of water vapor per pound-mass of dry air during production of the strand, storage of the strand at the geographic site where the elastic strand is made, shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is to be used as a raw material, storage of the elastic strand at the geographic site where the elastic strand is to be used as a raw material, use of the elastic strand as a raw material, or some combination thereof.

12. The method of claim 11 wherein the elastic strand is used as a raw material to produce a substrate composite comprising the elastic strand or an absorbent article comprising the elastic strand.
13. The method of claim 12 wherein the specific humidity around the elastic strand does not exceed about 0.005 pounds-mass of water vapor per pound-mass of dry air.

14. The method of claim 12 wherein the elastic strand’s exposure to water vapor is regulated during shipping of the strand between the geographic site where the elastic strand is made and the geographic site where the elastic strand is used as a raw material.

15. The method of claim 14 wherein regulating the strand’s exposure to water vapor comprises controlling the temperature around the strand or around a container that contains the strand.

16. The method of claim 15 wherein the temperature is controlled to a value not exceeding about 55 degrees Fahrenheit.

17. The method of claim 14 wherein regulating the strand’s exposure to water vapor comprises controlling the humidity around the strand or around a container that contains the strand.

18. The method of claim 2 further comprising the step of regulating the elastic strand’s exposure to water vapor before, during, or after heating, the method comprising the additional steps of:
   placing the strand in a container comprising a barrier material; and
   closing the container.

19. The method of claim 18 wherein the container comprising a barrier material is closed at a time $t_1$, time $t_1$ being after the time when the strand is first produced and before the time when the strand is shipped from the geographical site at which the strand is first produced to the geographical site at which the strand is used.

20. The method of claim 19 wherein the specific humidity around the strand does not exceed 0.017 pounds-mass of water vapor per pound-mass of dry air between time $t_1$ and time $t_2$, time $t_2$ being the time when the closed container comprising a barrier material is first opened.

21. The method of claim 19 wherein the specific humidity around the strand does not exceed 0.01 pounds-mass of water vapor per pound-mass of dry air between time $t_1$ and
time \( t_2 \), time \( t_2 \) being the time when the closed container comprising a barrier material is first opened.

22. The method of claim 19 wherein the specific humidity around the strand does not exceed 0.005 pounds-mass of water vapor per pound-mass of dry air between time \( t_1 \) and time \( t_2 \), time \( t_2 \) being the time when the closed container comprising a barrier material is first opened.

23. The method of claim 20 wherein the barrier material comprises polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chloride, polyester, polycarbonate, nylon, cellulose, or a combination thereof.

24. The method of claim 23 wherein closing the container comprising a barrier material comprises heat sealing the container, the barrier material, or both.

25. The method of claim 24 further comprising the step of placing desiccant material with the strand before heat sealing the container, the barrier material, or both.

26. The method of claim 25 wherein the desiccant material comprises calcium chloride, calcium sulfate, silica gel, a molecular sieve, \( \text{Al}_2\text{O}_3 \), or some combination of thereof.

27. The method of claim 24, 25, or 26 further comprising the steps of displacing any mixture of air and water vapor from the interior of the container comprising a barrier material with an inert dry gas before heat sealing the container, the barrier material, or both; placing a humidity indicator inside the container comprising a barrier material before heat sealing the container, the barrier material, or both; or both.

28. Elastic strand handled or treated by the method of claims 1, 5, 6, 9, 16, 17, 18, 22, or 23.


30. A disposable absorbent product comprising the substrate composite of claim 29.
Internationa Search Report  

A. Classification of Subject Matter  
IPC 7 D02J13/00 D01F6/70 A61F13/15  

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

B. Fields Searched  
Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 D02J D01F A61F  

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

Electronic database consulted during the international search (name of database and, where practical, search terms used)  
EPO-Internal, WPI Data, PAJ  

C. Documents Considered to Be Relevant  
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Further documents are listed in the continuation of box C.  

Patent family members are listed in annex.  

Date of the actual completion of the international search  
16 March 2001  

Date of mailing of the international search report  
02/04/2001  

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Authorized officer  
Tarrida Torrel, J
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