THERMAL MODERATING DONNABLE ELASTIC ARTICLES

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Abstract

Disclosed herein are thermal moderating donnable elastic articles suitable for a variety of uses. The thermal moderating donnable elastic articles include at least one thermal moderating elastic laminate material, the laminate including at least one polymeric elastic layer and at least one extensible fibrous layer, and the extensible fibrous layer including at least one thermal regulating additive. Such thermal moderating donnable elastic articles are useful for use in protective wear products, health care and medical care products, gloves, compressive bandages and comfort-providing wraps, and the like, and are capable of moderating temperature or providing temperature change sensation to the wearer's body part enveloped by the thermal moderating donnable elastic article. Also disclosed herein are thermal moderating elastic laminate materials having one or more thermally conductive additive materials.
THERMAL MODERATING DONNABLE ELASTIC ARTICLES

BACKGROUND OF THE INVENTION

[0001] For many types of articles worn by consumers, the ability of the article to provide temperature regulation is an added benefit. Examples include heat generating transdermal drug delivery devices, wherein the generation of heat improves transport of the medication through the wearer’s skin. Other examples include thermal wrap materials having heat generating cells to provide warmth to, for example, the wearer’s back, or cold packs to provide temperature relief or therapeutic benefit provide comfort to an injured body part.

[0002] Fabrics including temperature regulating or moderating mechanisms are also known. For example, phase change materials having reversible thermal properties may be provided in or on fabrics such as woven or nonwoven or textile materials, and the like. As a specific example, phase change materials having reversible thermal properties may be incorporated as encapsulated or microencapsulated additives into the thermoplastic melt prior to spinning fibers therefrom, and the spun fibers used in making the fabrics. Alternatively, thermal regulating or moderating phase change materials may be powder coated onto the various materials and fabrics, or mixed into an emulsion or other mixture and then coated onto the various materials and fabrics.

[0003] Such fabrics incorporating a temperature regulating or moderating mechanism such as phase change materials or other materials having reversible thermal properties, while able to provide thermal moderation and comfort to a wearer, still suffer from drawbacks including general relative inflexibility and inelasticity due to the nature of the underlying fabric, stiffness added by the coating, or both.

SUMMARY OF THE INVENTION

[0004] The present invention provides thermal moderating donnable elastic articles. The thermal moderating donnable elastic article is an article capable of being donned by the wearer or user, that is, capable of having a body part inserted into the article or capable of being wrapped around a body part of a wearer, such that the body part is substantially enveloped by the donnable article. The thermal moderating donnable elastic article includes at least one thermal moderating elastic laminate material. The thermal moderating elastic laminate material includes at least one polymeric elastic layer and at least one extensible fibrous layer that have been laminated together. The extensible fibrous layer includes at least one thermal regulating additive.

[0005] In embodiments, the extensible fibrous layer or layers may be nonwoven materials such as gathered nonwovens, necked nonwovens, or carded webs, and the thermal regulating additive may be such as phase change materials. In embodiments, the thermal moderating donnable elastic article may be configured with the thermal moderating elastic laminate material further including a second extensible fibrous layer laminated to the opposite side of said polymeric elastic layer, and the second extensible fibrous layer may desirably also include one or more thermal regulating additives. The polymeric elastic layer may include or be such as elastomeric film layers, elastic strand layers, elastic meltblown layers, combinations of the foregoing, and the like. The thermal moderating donnable elastic article may also include one or more thermochromic pigments, and the thermal moderating donnable elastic article may be configured, for example, in the form of gloves, headbands, limb sleeves, and the like.

[0006] In another aspect, provided are thermal moderating elastic laminate materials including additives to enhance thermal energy transfer, such as one or more thermally conductive additives that may be included in the polymeric elastic layer, the extensible fibrous layer(s), or combinations thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a perspective view of a thermal moderating donnable elastic article in accordance with one exemplary embodiment.

[0008] FIG. 2 is an exploded perspective view of various layers of a thermal moderating elastic laminate material that may be used to form a thermal moderating donnable elastic article in accordance with one exemplary embodiment.

[0009] FIG. 2a is an exploded perspective view similar to that of FIG. 2 but with an elastic layer configured into a scrim.

[0010] FIG. 3 is a perspective view of the layers in FIG. 2a in an assembled shape.

[0011] FIG. 4 is a detailed perspective view of a seam formed in constructing a thermal moderating donnable elastic article.

[0012] FIG. 5 is a detailed perspective view of a flush seam bond formed in constructing a thermal moderating donnable elastic article.

[0013] FIG. 6 is a diagrammatic cross-sectional view illustrating a cutting and sealing horn that may be used in construction of the articles of the invention.

[0014] FIG. 7 is a diagrammatic cross-sectional view illustrating an embodiment of an elastic laminate material.

[0015] Repeat use of reference characters in the present specification and drawings is intended to represent the same or analogous features or elements of the invention.

DEFINITIONS

[0016] As used herein and in the claims, the term "comprising" is inclusive or open-ended and does not exclude additional unrecited elements, compositional components, or method steps. Accordingly, the term "comprising" encompasses the more restrictive terms "consisting essentially of" and "consisting of".

[0017] As used herein, the terms "elastic" and "elastomeric" are generally used to refer to a material or article that, upon application of a stretching or biasing force, is capable of being extended or stretched or elongated, in at least one direction, without rupturing, to an extended or elongated dimension which is at least 120 percent of the material's non-extend or unstretched dimension, and which upon release of the stretching, biasing force will recover at least about 30 percent of its elongation. By way of example only, an elastic material having a relaxed, unstretched length of 10 centimeters may be elongated to at least about 12 centimeters by the application of a stretching or biasing force. Upon release of the stretching or biasing force the elastic material will recover to a length of not more than 11.4 centimeters.

[0018] As used herein the term "polymer" generally includes but is not limited to, homopolymers, copolymers, such as for example, block, graft, random and alternating copolymers, terpolymers, etc and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible geometrical
configurations of the material. These configurations include, but are not limited to isotactic, syndiotactic and random symmetries.

[0019] As used herein the term “thermoplastic” or “thermoplastic polymer” refers to polymers that will soften and flow or melt when heat and/or pressure are applied, the changes being reversible.

[0020] As used herein the term “fibers” refers to both staple length fibers and substantially continuous filaments, unless otherwise indicated. As used herein the term “substantially continuous” with respect to a filament or fiber means a filament or fiber having a length much greater than its diameter, for example having a length to diameter ratio in excess of about 15,000 to 1, and desirably in excess of 50,000 to 1.

[0021] As used herein the term “monocomponent” fiber refers to a fiber formed from one or more extruders using only one polymer composition. This is not meant to exclude fibers or filaments formed from one polymeric extrudate to which small amounts of additives have been added for color, anti-static properties, lubrication, hydrophilicity, etc.

[0022] As used herein the term “multicomponent fibers” refers to fibers or filaments that have been formed from at least two component polymers, or the same polymer with different properties or additives, extruded from separate extruders but spun together to form one fiber or filament. Multicomponent fibers are also sometimes referred to as conjugate fibers or bicomponent fibers, although more than two components may be used. The polymers are arranged in substantially constantly positioned distinct zones across the cross-section of the multicomponent fibers and extend continuously along the length of the multicomponent fibers. The configuration of such a multicomponent fiber may be, for example, a concentric or eccentric sheath/core arrangement wherein one polymer is surrounded by another, or may be a side by side arrangement, an “islands-in-the-sea” arrangement, or arranged as pie-wedge shapes or as stripes on a round, oval or rectangular cross-section fiber, or other configurations. Multicomponent fibers are taught in U.S. Pat. No. 5,108,820 to Kaneko et al. and U.S. Pat. No. 5,336,552 to Strack et al. Conjugate fibers are also taught in U.S. Pat. No. 5,382,400 to Pike et al. and may be used to produce crimp in the fibers by using the differential rates of expansion and contraction of the two (or more) polymers. For two component fibers, the polymers may be present in ratios of 75/25, 50/50, 25/75 or any other desired ratios. In addition, any given component of a multicomponent fiber may desirably include two or more polymers as a multicomponent blend component.

[0023] As used herein the terms “biconstituent fiber” or “multicomponent fiber” refer to a fiber or filament formed from at least two polymers, or the same polymer with different properties or additives, extruded from the same extruder as a blend. Multicomponent fibers do not have the polymer components arranged in substantially constantly positioned distinct zones across the cross-section of the multicomponent fibers; the polymer components may form fibrils or protofibrils that start and end at random.

[0024] As used herein the terms “nonwoven web” or “nonwoven fabric” refer to a web having a structure of individual fibers or filaments that are interlaid, but not in an identifiable manner as in a knitted or woven fabric. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, airlaying processes, and carded web processes. The basic weight of nonwoven fabrics is usually expressed in grams per square meter (gsm) or ounces of material per square yard (osy) and the filament diameters useful are usually expressed in microns. (Note that to convert from osy to gsm, multiply osy by 33.91).

[0025] As used herein, “thermal point bonding” involves passing a fabric or web of fibers or other sheet layer material to be bonded between a heated calender roll and an anvil roll. The calender roll is usually, though not always, patterned on its surface in some way so that the entire fabric is not bonded across its entire surface. As a result, various patterns for calender rolls have been developed for functional as well as aesthetic reasons. One example of a pattern has points and is the Hansen Pennings or “H&P” pattern with about a 30 percent bond area with about 200 bonds per square inch (about 31 bonds per square centimeter) as taught in U.S. Pat. No. 3,855,046 to Hansen and Pennings. The H&P pattern has square point or pin bonding areas wherein each pin has a side dimension of 0.038 inches (0.965 mm), a spacing of 0.070 inches (1.778 mm) between pins, and a depth of bonding of 0.023 inches (0.584 mm). The resulting pattern has a bonded area of about 29.5 percent. Another typical point bonding pattern is the expanded Hansen and Pennings or “EHP” bond pattern that produces a 15 percent bond area with a square pin having a side dimension of 0.037 inches (0.94 mm), a pin spacing of 0.097 inches (2.466 mm) and a depth of 0.039 inches (0.991 mm). Other common patterns include a high density diamond or “HDD pattern”, that includes point bonds having about 460 pins per square inch (about 71 pins per square centimeter) for a bond area of about 15 percent to about 23 percent, a “Rumish” diamond pattern with repeating diamonds having a bond area of about 8 percent to about 14 percent and about 52 pins per square inch (about 8 pins per square centimeter) and a wire weave pattern looking as the name suggests, e.g. like a window screen. As still another example, the nonwoven web may be bonded with a point bonding method wherein the arrangement of the bond elements or bonding “pins” are arranged such that the pin elements have a greater dimension in the machine direction than in the cross-machine direction. Linear or rectangular-shaped pin elements with the major axis aligned substantially in the machine direction are examples of this. Alternatively, or in addition, useful bonding patterns may have pin elements arranged so as to leave machine direction running “lanes” or lines of unbonded or substantially unbonded regions running in the machine direction, so that the nonwoven web material has additional give or extensibility in the cross machine direction. Such bonding patterns as are described in U.S. Pat. No. 5,620,779 to Levy et al., incorporated herein by reference in its entirety, may be useful, such as for example the “rib-knit” bonding pattern therein described. Typically, the percent bonding area varies from around 10 percent to around 30 percent or more of the area of the fabric or web. Thermal bonding imparts integrity to individual layers or webs by bonding fibers within the layer and/or for laminates of multiple layers, such thermal bonding holds the layers together to form a cohesive laminate material.

[0026] The terms “spunbond” or “spunbond nonwoven web” refer to a nonwoven fiber or filament material of small diameter fibers that are formed by extruding molten thermoplastic polymer as fibers from a plurality of capillaries of a spinneret. The extruded fibers are cooled while being drawn by an eductive or other well known drawing mechanism. The drawn fibers are deposited or laid onto a forming surface in a generally random manner to form a loosely entangled fiber
web, and then the laid fiber web is subjected to a bonding process to impart physical integrity and dimensional stability. The production of spunbond fabrics is disclosed, for example, in U.S. Pat. Nos. 4,340,563 to Appel et al., U.S. Pat. No. 3,692,618 to Dorschner et al., and U.S. Pat. No. 3,802,817 to Matsuki et al., all incorporated herein by reference in their entireties. Typically, spunbond fibers or filaments have a weight-per-unit-length in excess of about 1 denier and up to about 6 denier or higher, although both finer and heavier spunbond fibers can be produced. In terms of fiber diameter, spunbond fibers often have an average diameter of larger than 7 microns, and more particularly between about 10 and about 25 microns, and up to about 30 microns or more.

[0027] As used herein the term “meltblown fibers” means fibers or microfibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments or fibers into converging high velocity gas (e.g., air) streams that attenuate the fibers of thermoplastic material to reduce their diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly dispersed meltblown fibers. Such a process is disclosed, for example, in U.S. Pat. No. 3,849,241 to Bantin. Meltblown fibers may be continuous or discontinuous, are often smaller than 10 microns in average diameter and are frequently smaller than 7 or 5 microns in average diameter, or even smaller than 3 microns in average diameter, and are generally tacky when deposited onto a collecting surface.

[0028] As used herein “coform” or “coformed web” refers to composite nonwoven webs formed by processes in which two or more fiber types are intermingled into a heterogeneous composite web, rather than having the different fiber types supplied as separate or distinct web layers, as is the case in a laminate composite material. Certain well-known coform processes are described in U.S. Pat. No. 4,818,464 to Lau, U.S. Pat. No. 4,100,324 to Anderson et al., and U.S. Pat. Nos. 5,508,102 and 5,536,624 to Geoger et al., the disclosures of which are incorporated herein by reference in their entireties, wherein at least one melting blowing diehead is arranged near a chute or other delivery device through which other materials or fiber types are added while the web is being formed. Such other materials or fiber types disclosed in these patents include staple fibers, cellulosic fibers, and/or superabsorbent materials and the like. The other fibers are interconnected by and held captive within a matrix of microfibers, such as meltblown microfibers, by mechanical entanglement of the microfibers with the other fibers, the mechanical entanglement and interconnection of the microfibers and other fibers alone forming a coherent integrated composite fibrous web structure. The meltblown fibers may be made of or include various polymers, including elastomeric polymers.

[0029] As used herein, the term “ultrasonic bonding” refers to a process in which materials (fibers, webs, films, etc.) are joined by passing the materials between a sonic horn and anvil roll. An example of such a process is illustrated in U.S. Pat. No. 4,374,888 to Bornslaeger, the entire contents of which is incorporated herein by reference in its entirety for all purposes.

DETAILED DESCRIPTION OF THE INVENTION

[0030] The present invention provides thermal moderating donnable elastic articles. The invention will be described with reference to the following description and Figures which illustrate certain embodiments. It will be apparent to those skilled in the art that these embodiments do not represent the full scope of the invention which is broadly applicable in the form of variations and equivalents as may be embraced by the claims appended hereto. Furthermore, features described or illustrated as part of one embodiment may be used with another embodiment to yield still further embodiments. It is intended that the scope of the claims extend to all such variations and equivalents.

[0031] The thermal moderating donnable elastic article is an article capable of being donned by the wearer or user, that is, capable of having a body part inserted into the article or capable of being wrapped around a body part of a wearer, such that the body part is substantially enveloped or encircled by the donnable article. For example, an article in the form of a glove substantially envelops or encircles the hand and/or fingers of a wearer (depending on whether it is a whole hand glove or “fingerless” glove). Similarly, for example, a headband or joint wrap or sleeve substantially envelops or encircles the head or joint, respectively, of the wearer. The thermal moderating donnable elastic article includes at least one thermal moderating elastic laminate material. The thermal moderating elastic laminate material includes at least one polymeric elastic layer and at least one extensible fibrous layer that have been laminated together. The extensible fibrous layer includes at least one thermal regulating additive.

[0032] As stated above, an elastic article is an article capable of stretch and recovery; that is, at a minimum the elastic article is capable of being extended or elongated upon the application of force to an extended length at least 120 percent of its original length, and is also capable of recovering at least 30 percent of its elongation. In terms of extensibility or stretchability, an elastic material may have greater capacity for stretch or elongation without rupture, such as being capable of being stretched to an extended, biased length which is at least about 150 percent its relaxed, unstretched length. For many uses or applications, it may be desirable for an elastic material to be capable of being stretched without rupture to at least 200 percent of its unstretched length or dimension, and for other uses it may be desirable for the elastic material to be capable of being stretched without rupture to at least 250 percent, or even 300 percent (or even more) of its unstretched length or dimension.

[0033] In terms of the level of elastic recovery, an elastic material may be capable of recovering at least about 50 percent or more of the extension length. Depending on the desired use or application, an elastic material may desirably be capable of recovering about 75 percent, or even about 85 percent or more of the extension length, and for still other uses an elastic material may desirably be capable of recovering substantially all of the extension length. As a particular numerical example to aid the understanding of the foregoing, for an elastic material capable of being stretched to 200 percent of its original length and having a 75 percent recovery, if the material has a relaxed, unstretched length of 10 centimeters, the material may be stretched to at least 20 centimeters by a stretching force, and upon release of the stretching force will recover to a length of not more than 12.5 centimeters.

[0034] As stated, the thermal moderating donnable elastic article includes a thermal moderating elastic laminate material. The thermal moderating elastic laminate material includes at least one polymeric elastic layer. The polymeric elastic layer provides the properties of stretch and recovery to the article. The polymeric elastic layer may be or include such
as an elastic film layer, an elastic scrim or netting layer, an elastic spunbond, meltblown or other nonwoven material, elastic strands, and the like, and combinations of the foregoing. Suitable polymers for use in making the polymeric elastic layer include any elastic polymer or polymers known to be suitable elastomeric fiber, film or strand forming resins including, for example, elastic polyesters, elastic polyurethanes, elastic polyamides, elastic co-polymers of ethylene and at least one vinyl monomer, block copolymers, and elastic polyolefins.

Examples of elastic block copolymers include those having the general formula A-B-A' or A-B, where A and A' are each a thermoplastic polymer endblock that contains a styrenic moiety such as a poly(vinyl arene) and where B is an elastomeric polymer midblock such as a conjugated diene or a lower alkene polymer such as for example polystyrene-poly(ethylene-butylene)-polystyrene block copolymers. Also included are polymers composed of an A-B-A-B tetra-block copolymer, as discussed in U.S. Pat. No. 5,332,613 to Taylor et al. An example of such a tetra-block copolymer is a styrene-poly(ethylene-propylene)-styrene-poly(ethylene-propylene) or SEPSEP block copolymer. These A-B-A'- and A-B-A-B copolymers are available in several different formulations from Kraton Polymers U.S., L.L.C., of Houston, Tex., under the trade designation KRATON®. Other commercially available block copolymers include the SEPS or styrene-poly(ethylene-propylene)-styrene elastic copolymer available from Kuraray Company, Ltd., of Okayama, Japan, under the trade name SEPTON®.

Examples of elastic polyolefins include ultra-low density elastic polypropylenes and polyethylene, such as those produced by “single-site” or “metallocene” catalysis methods. Such polymers are commercially available from the Dow Chemical Company of Midland, Mich., under the trade name ENGAGE®, and described in U.S. Pat. Nos. 5,278,272 and 5,272,236 to Lai et al. entitled “Elastic Substantially Linear Olefin Polymers”. Also useful are certain elastomeric polypropylenes such as are described for, example, in U.S. Pat. No. 5,539,056 to Yang et al. and U.S. Pat. No. 5,596,052 to Resconi et al., incorporated herein by reference in their entirety, and polyethylenes such as AFFINITY® EG 8200 from Dow Chemical of Midland, Mich. as well as EXACT® 4049, 4011 and 4041 from the ExxonMobil Chemical Company of Houston, Tex., as well as blends. Still other elastomeric polymers are available, such as the elastic polyolefin resins available under the trade name VISTAMAXX® from ExxonMobil Chemical Company, Houston, Tex., and the polyolefin (propylene-ethylene copolymer) elastic resins available under the trade name VERSIFY® from Dow Chemical, Midlands, Mich.

In addition to the polymeric elastic layer, the thermal moderating elastic laminate material includes one or more extensible fibrous layers, at least one extensible fibrous layer including at least one thermal regulating additive. The extensible fibrous layer may be such as nonwoven fibrous materials, wovens, textiles, and the like. Nonwoven materials are known in the art, such as spunbond materials, carded webs, meltblown materials, coformed webs, and the like, and/or composites or laminates of the foregoing, may be particularly suitable due to ease and relative inexpense of production. The fibers utilized in such materials may be monocomponent, multicomponent, and/or multiconstituent fibers. Such fibrous materials, including nonwoven fibrous materials, are often produced using thermoplastic polymers.

Exemplary polymers known to be generally suitable in the making of fibrous web materials such as woven materials and nonwoven materials include for example polyolefins, polyesters, polyamides, polycarbonates and copolymers and blends thereof. It should be noted that the polymer or polymers selected may desirably contain other additives such as processing aids or treatment compositions to impart desired properties to the fibers, residual amounts of solvents, pigments or colorants and the like.

Suitable polyolefins include polyethylene, e.g., high density polyethylene, medium density polyethylene, low density polyethylene and linear low density polyethylene; polypropylene, e.g., isotactic polypropylene, syndiotactic polypropylene, blends of isotactic polypropylene and atactic polypropylene; polybutylene, e.g., poly(1-butene) and poly(2-butene); polypropylene, e.g., poly(1-pentene) and poly(2-pentene); or poly(3-methyl-1-pentene); and copolymers and blends thereof. Suitable copolymers include random and block copolymers prepared from two or more different unsaturated olefin monomers, such as ethylene/propylene and ethylene/butylene copolymers. Suitable polyamides include nylon 6, nylon 6/6, nylon 4/6, nylon 11, nylon 12, nylon 6/10, nylon 6/12, nylon 12/12, copolymers of caprolactam and alkylen oxide diamine, and the like, as well as blends and copolymers thereof. Suitable polyesters include poly(lactide) and poly(lactic acid) polymers as well as polyethylene terephthalate, polybutylene terephthalate, polytetramethylene terephthalate, polyethylene/xylene-1,4-dimethylene terephthalate, and isophthalate copolymers thereof, as well as blends thereof.

As stated, the fibrous layer or layers in the thermal moderating elastic laminate material are extensible. Generally, the extensible fibrous layer is capable of being extended or elongated along at least one direction to such an extent that the laminate material itself is capable of elastic stretch and recovery. That is, when the extensible fibrous layer is laminated to the polymeric elastic layer to form the elastic laminate, that laminated state the extensible fibrous layer should be capable of an extension of at least about a 120 percent. The extensible fibrous layer may be capable of extension or elongation to a greater extent, as described above.

Certain types of fibrous layers may have a minimal amount of extensibility in and of themselves, while other types of fibrous layers may benefit from specific treatments or constructional attributes to impart (or enhance) extensibility. For example, nonwoven carded webs or bonded carded webs may have a certain amount of extensibility as produced without the need of post-production processing to impart extensibility. “Carded webs” refers to nonwoven webs formed by carding processes as are known to those skilled in the art and further described, for example, in U.S. Pat. No. 4,488,928 to Alkhans and Schmidt which is incorporated herein in its entirety by reference. Briefly, carding processes involve starting with staple fibers in a bulky batt that is combed or otherwise treated to provide a web of generally uniform basis weight. Typically, the webs are thereafter bonded by such means as through-air bonding, thermal point bonding, adhesive bonding, and the like.

Other types of fibrous layers, particularly nonwoven layers such as spunbond and meltblown layers, if made from essentially inelastic polymers, may exhibit too little extensibility initially or as originally produced. If so, it may be desirable to impart additional extensibility to these (or other fibrous layers) by such methods as gathering or necking of the
fibrous layer to produce an extensible nonwoven layer. For example, stretch-bonded laminate materials employ gathering to impart additional extensibility to one or more layers in the stretch-bonded laminate. “Stretch-bonded laminate” refers to a composite material having at least two layers in which one layer is a gatherable layer and the other layer is an elastic layer. The layers are joined together when the elastic layer is extended from its original condition so that upon relaxing the layers, the gatherable layer is gathered. Such a multilayer composite elastic material may be stretched at least to the extent that the gatherable material having been gathered allows the elastic material to elongate. One type of stretch-bonded laminate is disclosed, for example, by U.S. Pat. No. 4,720,415 to Vander Wielen et al., the entire contents of which are incorporated herein by reference in its entirety for all purposes. Other composite elastic materials are disclosed in U.S. Pat. No. 4,789,699 to Kieffer et al., U.S. Pat. No. 4,781,966 to Taylor and U.S. Pat. Nos. 4,657,802 and 4,652,487 to Morman and U.S. Pat. No. 4,655,760 to Morman et al., the contents of which are incorporated herein by reference in their entirety.

[0042] As mentioned, another method for increasing the extensibility of the extensible fibrous layer is necking. The terms “necking” or “neck stretching” interchangeably refer to a method of elongating a fibrous or other material or fabric, generally in the machine direction, to reduce its width (cross-machine direction) in a controlled manner to a desired amount. The controlled elongation or stretching of the material may take place under cool, room temperature or greater temperatures and is limited to an increase in overall dimension in the direction being stretched up to the elongation required to break the fabric, which in most cases is about 1.2 to 1.6 times. When relaxed, the material may revert toward, but generally does not return to, its original dimensions. Such a process is disclosed, for example, in U.S. Pat. No. 6,897,413 to Meitner and Noethis, and U.S. Pat. Nos. 4,965,122, 4,981,747 and 5,114,781 to Morman, the entire contents of which are incorporated herein by reference in their entirety for all purposes.

[0043] Additionally, a “reversibly necked” material refers to a material that possesses stretch/extensibility and also some recovery characteristics on its own. Such a reversibly necked material may be formed by necking a material, then heating the necked material, and cooling the material. Such a process is disclosed in U.S. Pat. No. 4,965,122 to Morman, the entire contents of which are incorporated by reference herein in its entirety for all purposes. Generally, when a necked material is joined as a composite or laminate material with an elastic layer, the composite is referred to as a “neck-bonded laminate” or “necked, bonded laminate”. Examples of neck-bonded laminates are as those described in U.S. Pat. Nos. 5,226,992, 4,981,747, 4,965,122 and 5,336,545 to Morman, the entire contents of which are incorporated herein by reference in their entirety for all purposes.

[0044] As described above, the extensible fibrous layer includes one or more thermal regulating additives. Generally speaking, a thermal regulating additive is a material or combination of materials capable of providing or absorbing heat at a given temperature, for example at ambient room temperature, at normal human body temperature, etc. By absorbing or releasing thermal energy such an additive can reduce or eliminate heat transfer at a given temperature or temperature range. One example of a class of thermal regulating additives is called phase change materials, which are materials capable of undergoing a reversible phase transition at a relatively precise temperature or temperature range. Phase change materials include, for example, such materials as paraffinic hydrocarbons and waxes, low molecular weight aliphatic hydrocarbons, and acids of natural oils and waxes. At the phase change temperature, a characteristic of phase change material during the heating cycle is to absorb and hold a quantity of thermal energy at a relatively constant temperature during the phase change and until most or all of the phase change material has undergone the phase change. Phase change materials are available in a variety of forms from, for example, Outlast Technologies, Inc. (Boulder, Colo.).

[0045] Therefore, such a material can be used as thermal moderator or barrier to heat, because a quantity of thermal energy must be absorbed by the phase change material until most or all of the material has undergone solid-to-liquid phase change, before its temperature can begin to increase. When placed next to the skin of a wearer, this absorption of heat from the wearer’s skin and into the phase change material provides a cooling effect to the user. Alternatively, a phase change material can provide a thermal moderating effect as a barrier to chilling where the phase change material is substantially in a liquid phase and must release a quantity of thermal energy or heat to undergo the liquid-to-solid phase change, and before its temperature can begin to decrease.

[0046] Such phase change material thermal regulating additives may be incorporated into a thermoplastic melt from which fibers included in an extensible fibrous layer, such as an extensible nonwoven layer, are produced. Alternatively, or in addition, such phase change material thermal regulating additives may be added to the extensible fibrous layer via topical coating or impregnation of the extensible fibrous layer with the phase change material thermal regulating additive in powder form or in liquid forms such as suspensions or emulsions, etc. As an example, U.S. Pat. No. 6,689,466 to Hartmann describes phase change compositions which, as described therein, are temperature stabilized and therefore suitable for, among other things, melt extrusion processes such as melt spinning of fibrous materials. The phase change material compositions described therein include phase change materials and a stabilizing agent such as antioxidants and thermal stabilizers.

[0047] Exemplary phase change materials include, by way of example only, hydrocarbons (e.g., straight chain alkanes or paraffinic hydrocarbons, branched-chain alkanes, unsaturated hydrocarbons, halogenated hydrocarbons, and cyclic hydrocarbons), waxes, oils, fatty acids, fatty acid esters, dibasic acids, dibasic esters, 1-halides, primary alcohols, aromatic compounds, anhydrides (e.g., stearic anhydride), ethylene carbonate, polyhydric alcohols (e.g., 2,2-diethylyl-1,3-propanediol, 2-hydroxyethyl-2-methyl-1,3-propanediol, ethylene glycol, polyethylene glycol, pentaerythritol, dipentaerythritol, pentaglycerine, tetramethylyl ethane, neopentyl glycol, tetramethylol propane, monoaminopenterythritol, dimino-pentaerythritol, and tris(hydroxymethyl)acetic acid), polymers (e.g., polyethylene, polylethylene glycol, polypropylene, polypropylene glycol, polytetramethylyl glycol, and copolymers, such as polyacrylate or polymethacrylate with alkyl hydrocarbon side chain or with polyethylene glycol side chain and copolymers comprising polyethylene, polyethylene glycol, polypropylene, polypropylene glycol, or polytetramethylyl glycol), and mixtures thereof. It should be noted that although the phrases “phase change” and “phase transition” are commonly employed, phase change materials
may undergo either a solid/liquid (liquid/solid) phase transition or a solid/solid transition. In a solid/solid transition, the phase change material undergoes a phase transition that is between two solid states, such as a crystalline/mesocrystalline phase transition.

[0048] As mentioned above, the thermal regulating additive may desirably be coated onto or impregnated into the extensible fibrous layer, instead of (or in addition to) being incorporated into the polymer used in producing the fibers. Such coatings may be applied as a powder or liquid form. Liquid forms include aqueous or other liquid dispersions, suspensions and/or emulsions, may be formed, and may include components other than the thermal regulating additive or phase change material in the composition such as, for example, thickeners, adhesives or binders, including polymeric binders. Exemplary thermal regulating additive coatings for fabrics are disclosed, for example, in U.S. Pat. Nos. 6,207,738 and 6,514,362 to Zuckerman et al. Such coating compositions may be applied to the extensible fibrous layer by spraying, brushing, dipping or immersion, or, more particularly, by slot coating or applying as a foam and spreading with a knife or doctor blade, or the like. The coated fabric layer may then be air dried or dried by heat, heated air, oven drying, or other means.

[0049] As mentioned above, the thermal moderating elastic laminate material may be formed as a stretch-bonded laminate or neck-bonded laminate, wherein one or more extensible fibrous layers (at least one including a thermal regulating additive) are laminated to one or more polymeric elastic layers in the fashion described above. However, the thermal moderating elastic laminate material may be constructed with or having additional layers, and it is not required that the extensible fibrous layer including the thermal regulating additive be directly laminated to the elastic member(s).

[0050] As an example, a thermal moderating elastic laminate material may be constructed by laminating an extensible fibrous layer including a thermal regulating additive to an already-constructed stretch-bonded laminate material. In this case, the stretch-bonded laminate was previously constructed having, for example, two gathered spunbond laminates laminated to either surface of an elastic layer. Then, the already-constructed stretch-bonded laminate may be elongated and held thus while one or more extensible fibrous layers (thermal regulating additive-containing) is laminated to the extended stretch-bonded laminate. Therefore, in this construction, the initial stretch-bonded laminate material acts as the polymeric elastic layer in the thermal moderating elastic laminate material.

[0051] Turning now to FIG. 1, an exemplary embodiment of a thermal moderating donnable elastic article is shown schematically. As shown in FIG. 1, the thermal moderating donnable elastic article is configured in the form of a glove 10, capable of covering or enveloping the hand of a wearer. Glove 10 is formed from thermal moderating elastic laminate material 12, and includes in this embodiment two extensible fibrous layers 16, 18. One or both of extensible fibrous layers 16, 18 contains one or more thermal regulating additive(s). The thermal moderating elastic laminate material 12 may be such as the above-described stretch-bonded laminate material or neck-bonded laminate material.

[0052] FIG. 2 shows various components of a thermal moderating elastic laminate material such as stretch-bonded laminate material 12 that may be used to make up the donnable article, such as glove 10. The polymeric elastic layer 36 of the stretch-bonded laminate 12 may be made of a plurality of elastic strands 14. Any type of elastic strands 14 may be used in accordance with various exemplary embodiments. For example, the elastic strands 14 may be LYCRA® that is manufactured by E.I. DuPont of Wilmington, Del., or the like, or may be thermoplastic elastic strands.

[0053] Although described as being a plurality of elastic strands 14, the polymeric elastic layer 36 may incorporate other elements in addition to the elastic strands 14. For example, the elastic layer 36 may include a filler or binding agent that acts to hold the elastic strands 14 in relation to one another, may include elastic meltable fibers, elastic films, etc. In any event, in constructing the thermal moderating elastic laminate material 12 (in this case, a stretch-bonded laminate), the elastic strands are extended or elongated and then attached to or laminated to the gatherable layers 38 and 40 when the elastic strands 14 are in the extended condition. The elastic strands 14 are then allowed to retract from the extended condition, thereby gathering layers 38 and 40. Layers 38 and 40 may be or include a first nonwoven web 16 and a second nonwoven web 18 and, as mentioned, one or both include a thermal regulating additive.

[0054] As shown in FIG. 2a, the polymeric elastic layer 36 may be in the form of an arrangement of strands 14 that are in a grid-like or mesh type shape, or netting. The grid type of arrangement of FIG. 2a will allow for the multi-dimensional elasticity of the thermal moderating elastic laminate material if the polymeric elastic layer or mesh 36 is extended in more than one direction when the layers 38, 40 (represented by exemplary nonwovens 16 and 18) are attached or laminated to the mesh 36 and allowed to gather in two directions when mesh 36 is attached. Alternatively, with respect to either the parallel strands of FIG. 2 or mesh-type polymeric elastic layer of FIG. 2a, multi-dimensional elasticity in the final thermal moderating elastic laminate material may also be achieved by utilizing necked materials 38, 40, and only having the polymeric elastic layer 36 extended during lamination in one direction (generally, a direction substantially parallel to the length dimension of strands 14 as shown in FIG. 2). It should be noted, however, in accordance with other exemplary embodiments the elastic strands 14 may be arranged in any desired direction so as to accommodate stretching in various directions. It should also be noted as described above, that the polymeric elastic layer may be elastic films, elastic meltable or spunbond webs, etc., in place of the elastic strands shown.

[0055] FIG. 3 shows a thermal moderating elastic laminate material represented by a stretch-bonded laminate 12 that has already been laminated in its component parts and is now in a relaxed position such that the facing materials (extensible nonwoven layers 16 and 18) have been gathered. As shown, wrinkles 20 are formed in the nonwoven layers 16 and 18. The wrinkles 20 may extend through the entire nonwoven layer 16 or 18 so that they are essentially on both sides of the nonwoven layer 16 or 18. The stretch-bonded laminate 12 thus has a certain degree of hidden stretchability that allows for the stretch-bonded laminate 12 to function well when used in or as a form-fitting article, capable of expanding and contracting to fit the movements of the body part of the wearer that is enveloped by the thermal moderating donnable elastic article.

[0056] For many of the thermal moderating donnable elastic articles desirably constructed using the thermal moderating elastic laminate material, it may be useful to bond or seam together more than one thermal moderating elastic laminate
material, or to bond or seam one thermal moderating elastic laminate material to itself. For example, one useful form of thermal moderating donnable elastic article is a thermal moderating headband. Such a headband may be expeditiously constructed by looping an appropriate length and width piece of a thermal moderating elastic laminate material upon itself and then bonding ends together to form a complete loop. Bonding may be performed by such methods as thermal spot or line bonding, adhesive bonding, stitch bonding, ultrasonic bonding, and the like, and may also be via releasable bonding such as, for example, a mechanical fastening such as snaps, buttons, hook and loop fasteners, etc.

**[0057]** FIG. 4 shows a cut away view of a portion of a thermal moderating donnable elastic article, to enable better examination of exemplary bonding or seaming. As shown in FIG. 4, a first thermal moderating elastic laminate material 42 is attached to a second thermal moderating elastic laminate material 44 in a manner forming a seam 24. The seam 24 shown in FIG. 4 may be formed by such as ultrasonic bonding or welding, or thermal bonding, and as shown in FIG. 4 may be constructed as a series of bond or weld spots along a single line, although of course, depending on the strength of bond or seam desired, bonding via more than one line of spots or via one or more substantially continuous lines is also possible. In addition, although the seam here is formed from two pieces of laminate, as mentioned above such seams may be constructed by bonding together two edges or sides of a single piece of thermal moderating elastic laminate material.

**[0058]** The seam 24 may have a width 26 that is suitable in accordance with the desired end-use of the thermal moderating donnable elastic article. Generally speaking, the width 26 of seam 24 may be up to about 5 millimeters in length, or more, depending on the embodiment. Alternatively, the width 26 of the seam 24 may be up to about 3 millimeters, up to 2 millimeters, or one millimeter or less in accordance with certain exemplary embodiments. The width 26 of the seam 24 may impact the comfort of the user during wearing of the article. For example, if the width 26 of the seam 24 is relatively large, the user may perceive the seam 24, when wearing the article, as somewhat of an irritant and may experience discomfort therefrom.

**[0059]** In accordance with one exemplary embodiment of the present invention, the first and second thermal moderating elastic laminate materials 42 and 44 may be connected to one another through one or more “flush” seam bonds 28 as shown in FIG. 5 (or, as mentioned above, a given thermal moderating elastic laminate material may thusly be connected to itself). Here, the seams are formed between the first and second thermal moderating elastic laminate materials 42 and 44 so as to have a width of generally equal to or less than about 1 millimeter. Such flush seams may desirably be produced via an ultrasonic simultaneous cutting and sealing operation.

**[0060]** Ultrasonic bonding methods are known in the art and may be performed, for example, by passing a fabric or other material amenable to ultrasonic bonding between a sonic horn emitting ultrasonic energy and an anvil, such as an anvil roller. Such processes are described, for example, in U.S. Pat. No. 4,374,888 to Bornslaeger. In a process particularly desirable where small seams are desired, a sealed seam between two or more portions of the thermal moderating elastic laminate material may be formed by an ultrasonic cut-and-seal process. The ultrasonic cut-and-seal process uses an ultrasonic bonding apparatus wherein two or more pieces are simultaneously cut to desired shape or dimension, and also are bonded or sealed together forming the seam, all in a single processing step. The shape of the edge seam along the sealed edge(s), that is, the width and the thickness of the sealed edge, is controlled by defining the dimensions of the bonding horn and/or bonding anvil which form the ultrasonic cutting and sealing die.

**[0061]** Turning briefly to FIG. 6, there is illustrated in a cross-sectional view an exemplary configuration for an ultrasonic bonding or welding horn for an ultrasonic die that is designed to be capable of producing a simultaneous cut and sealed edge in the thermal moderating elastic laminate material(s) used in the construction of the articles of the invention. In FIG. 6, the horn is configured to include a flat (horizontal) cross-section cutting section 210 and a tapered or angled welding or sealing section 220. In use, when the horn is applied to or lowered down onto the thermal moderating elastic laminate material(s) to be cut and sealed, the horn will be vibrating at a selected ultrasonic frequency (for example, 20,000 cycles per second). The vibrations transmit energy to the laminate materials as the energy passes into and through the material, which induces localized heating and essentially melts the thermoplastic elements and/or fuses them together. The flat cutting section 210 will press through or nearly all the way through the laminate materials, to at least partially contact an anvil section (not shown) of the ultrasonic apparatus. The flat cutting section will generally be fairly small, e.g. from about 0.1 to about 0.2 millimeters wide, although it may be smaller or larger upon need.

**[0062]** The angled sealing section 220 which is shown in FIG. 6 to have an angle of about 45 degrees, will also transmit energy and induce heating in the laminate material and thereby cause fusing or melting of thermoplastic materials, but without passing completely through the section or portion of the laminate material it contacts. Therefore, the sealed edge of the seam of the article thus produced will represent a mirror image of the horn geometry. That is to say, the sealed edge will have a generally triangular-shaped cross section having its thickest portion farthest from the cut edge, which thickest portion will correspond to the portion of the sealed edge made while in contact with the sealing section 220 at or near the point labeled “B” in FIG. 6. The sealed edge of an article thus produced will then thin gradually or taper in a direction moving outwardly away from the body of the article, with the thinnest portion of the sealed edge corresponding to the portion of the sealed edge made while in contact with cutting section 210 at or near the point labeled “A” in FIG. 6.

**[0063]** One will recognize that the ultrasonic die horn depicted in FIG. 6 is essentially symmetric, having similarly configured cutting sections and welding sections on both sides of the horn, which would be expected to produce similarly symmetrically configured cut and sealed edge(s) on the article it produces. However, the horn may alternatively be configured non-symmetrically, for example where it is desired to produce an article with (for example) a thicker, or a longer, or otherwise characteristically different sealed edge on one side of the article than the sealed edge on the other side of the body of the article.

**[0064]** Alternatively, only one side of the article may be desired to be sealed at a given time. Therefore, where an article having only a single cut and sealed edge is desired, an ultrasonic horn used to cut and seal those articles would have only a single cutting section/single welding section. It will also be recognized that the geometric configuration of the size or width dimension of the flat cutting section may vary, and
the size and/or angle of the welding or sealing section may vary from that shown, and still further that various suitable combinations may be readily determined through routine experimentation. Generally, the properties of the sealed edge may be controlled by the following factors: horn geometry, anvil geometry, horn down speed (rate at which the horn is brought into contact with and pressed through the fibrous web material(s)), horn pressure, and the amplitude and/or frequency of ultrasonic energy, and the scrub time as is known to those of skill in the art. As still yet another alternative, the laminate materials may be cut and sealed to produce the articles by using a flat horn which is brought down onto a patterned anvil surface.

[0065] As stated, the dimensions of the sealed edge seam(s) may desirably be less than about 1 millimeter in width and less than about 1 millimeter thick at its thickest part. Use of a flush seam bond such as flush seam bond 28 in FIG. 5 allows for a greater degree of comfort to the user or wearer of the thermal moderating donnable elastic article because the smaller seams may be less perceptible in use and therefore less likely to cause irritation. Additionally, flush seam bonding may allow for a thermal moderating donnable elastic article to be more easily donned and removed from whatever body part of the user is enveloped thereby because the seams, being generally smaller, are less likely to interfere with donning and removal.

[0066] In some embodiments, the sealed edge seam(s) may be less than about 0.5 millimeter in width and less than about 0.5 millimeter thick at the thickest part. In some further embodiments, the sealed edge seam(s) may be less than about 0.4 millimeter in width and less than about 0.4 millimeter thick at the thickest part. In still further embodiments, the sealed edge seam dimensions (either/or or both of the thickness and width) may be less than about 0.3 millimeter, or less than about 0.2 millimeter, or less than about 0.1 millimeter, and so forth. In particular embodiments, it may be useful for one or the other, or both, of the sealed edge seam dimensions to be as small as 50 micrometers.

[0067] In addition, it should be noted that these two dimensions do not have to be symmetric as discussed above with respect to horn geometry. For example, all of the dimension ranges stated above are independent, and it is possible to produce articles having sealed edge seam(s) that are of narrow width but, relative to the sealed edge seam width, quite thick, and vice versa. As a specific example of the foregoing, an article may have a sealed edge seam that is about 0.3 millimeters thick at its thickest part and about 0.5 millimeters wide.

EXAMPLE

[0068] As a specific example of an embodiment of the foregoing, a thermal moderating donnable elastic article was produced as follows. The thermal moderating donnable elastic article was produced in the form of a glove capable of providing cooling to the hand of the wearer. First, a stretch-bonded laminate material, constructed substantially as described above, was obtained from Kimberly-Clark Corporation, Ft. Worth, Tex. The stretch-bonded laminate material included two spunbond nonwoven outer facings as the fibrous layers, sandwiching a central layer of substantially parallel elastic strands.

[0069] The stretch-bonded laminate material as-obtained was capable of elastic stretch and recovery, and was therefore used to function as the polymeric elastic layer in constructing the thermal moderating elastic laminate material. The stretch-bonded laminate material was extended approximately to a 200 percent extension in the machine direction. That is, the stretch-bonded laminate material was extended to approximately twice its original length dimension. While the stretch-bonded laminate material was held in this extended position, a temperature moderating nonwoven fabric obtained from Outlast Technologies, Inc. (Boulder, Colo.) was adhesively laminated to the extended stretch-bonded laminate material to form the thermal moderating elastic laminate material. The temperature moderating nonwoven fabric was a fibrous layer (a spunbond fabric) that had been topically coated with a phase change material thermal regulating additive, similar to the coated fabrics described in above-mentioned U.S. Pat. Nos. 6,207,738 and 6,514,362 to Zuckerman et al. and, as-obtained, was substantially inelastic.

[0070] Following adhesive laminating, the entire thermal moderating elastic laminate material was allowed to relax or elastically retract, whereupon the temperature moderating nonwoven fabric gathered in the direction of retraction. Next, two pieces of this just-made thermal moderating elastic laminate material were placed in a face-to-face relation with the temperature moderating nonwoven fabric layers adjacent one another, and the pieces were cut into the shape of a glove. The two glove-shaped pieces of thermal moderating elastic laminate material were then sewn together to form a thermal moderating donnable elastic article in the form of a glove. When the glove was placed on the hand of a wearer, an immediate cooling sensation was notable on the skin of the hand as the phase change material absorbed heat from the wearer’s skin.

[0071] Although the thermal moderating donnable elastic articles described herein have been primarily described with respect to exemplary embodiments wherein the thermal moderating donnable elastic article is in the form of a glove, the thermal moderating donnable elastic articles are not limited to that form and are highly suited for a variety of uses. Any suitable donnable article capable of enveloping a body part of a wearer may be constructed as desired. For example, the thermal moderating donnable elastic article may be in the form of a headband capable of providing thermal regulation and physical comfort, such as cooling, to a wearer. In other instances, the thermal moderating donnable elastic article may be provided as an elastic compressive wrap material used, e.g., as a therapeutic device for limb or joint sprains or strains, while simultaneously providing the temperature regulation comfort of cooling. For example, a thermal moderating compressive wrap configured from the thermal moderating elastic laminate material may be provided in the form of a short limb sleeve which is drawn onto the arm or leg and located so as to envelop an injured joint or other injured portion of a limb, such as a wrist, ankle, knee, elbow, foot, etc. Alternatively, the article may be provided in the form of a longer limb sleeve capable of providing both compression and thermal regulation to substantially the entire limb.

[0072] It may also be desirable to provide visual cues as to the current status of the thermal capacity, such as by including one or more thermochromic pigment(s) in one or more components of the thermal moderating elastic laminate material. Inclusion of thermochromic pigment(s) could be configured to visually signal the user or a caregiver of the user, via a color change, when the heat carrying capacity of the thermal moderating donnable elastic article has become substantially exhausted. Generally such thermochromic pigment materials
and ingredients, as are known in the art, change color in response to changes in temperature. These materials change color at specific temperatures or temperature ranges. As mentioned above, a phase change material absorbs or releases heat without substantially changing temperature while undergoing phase transition and only begins to change temperature when substantially all of the phase change material has undergone phase transition. Therefore, a thermochromic pigment selected to have a transition temperature similar to that of the phase change material phase transition temperature may be used as ready signal of current exhaustion of the phase change material’s heat absorption or release capacity. Categories of such materials and ingredients include, for example, leuco dyes, available from Color Change Corporation, a company having offices in Streamwood, Ill.; leuco dyes available from Chromatic Technologies Incorporated, a business having offices in Colorado Springs, Colo.; and liquid crystals, available from Hallcrest, Inc., a business having offices in Glenview, Ill.

[0073] Examples of leuco dyes include spirulastones such as fluorine or crystal violet lactone, spiropripras, fulgides, and the like. Generally, such thermochromic systems include at least two chemical components; a leuco dye and a color developer. Leuco dyes are weak organic bases, and become colored in solution when in their protonated form (generally with the proton being donated by a color developer which is, for example, a weak acid). The leuco dye changes from color to colorless, or becomes “decolored” upon the addition of heat energy. Generally these materials change from colorless over an interval of about 2 to about 7 degrees Celsius—changing temperature shifts the equilibrium between the protonated and unprotonated forms of the leuco dye. As mentioned, color developers are weak acids (acting as proton donors or electron acceptors). Examples of such components include bisphenol A, octyl p-hydroxybenzoate, methyl p-hydroxybenzoate, 1,2,3-triazoles, 4-hydroxycumarin derivatives, and the like. A third component for an organic dye system (such as a leuco dye) may be a polar solvent, for example an alcohol, ester, ketone, or ether. Examples include lauryl alcohol (i.e., 1-dodecanol), cetyl alcohol (i.e., 1-hexadecanol), and butyl stearate.

[0074] Thermochromic ingredients may be employed or provided in various ways. For example, the organic dyes (for example, leuco dyes), may be provided as microencapsulated thermochromic pigment. Another category of thermochromic pigments or ingredients are liquid crystals, such as those available from the above-mentioned Hallcrest, Inc. These thermochromic materials tend to change color over a sharper, more precise temperature range compared to leuco dyes. Examples of such materials include cholesterol esters, cyanobiphenyls, and the like.

[0075] Generally speaking, regardless of the form of the thermochromic pigment or thermochromic ingredient used, the thermochromic pigment may be present in an amount sufficient to provide color to the material or article (prior to the thermochromic pigment undergoing transition) and to provide some level of contrast, after undergoing transition/decolorizing, compared to the previous color. Again, generally speaking, such sufficient amounts of thermochromic pigment may range from less than about 0.1 weight percent to about 10 weight percent by weight of the layer of the thermal moderating elastic laminate material onto which the thermochromic pigment is incorporated. Depending on desired end-use application, desired color intensity (and color contrast intensity), presence of other pigments (including non-thermochromic pigments) and the like, the thermochromic pigment in a given fabric layer may range from about 0.5 weight percent to about 7 weight percent of the layer, and more particularly, range from about 1 weight percent to about 5 weight percent of the layer. Further details relating to thermochromic ingredients may be found in U.S. Pat. No. 5,741,592 to Lewis, et al. and entitled “Microencapsulated System for Thermal Paper,” and in U.S. Pat. No. 4,028,118 to Nakasuji and entitled “Thermochromic Materials,” both of which are hereby incorporated by reference in their entireties in a manner consistent herewith.

[0076] In other embodiments, provided are thermal moderating elastic laminate materials including one or more thermally conductive materials. Addition of thermal conductors may potentially enhance the performance of the thermal regulating additive in the laminate. For example, the thermal moderating elastic laminate material may incorporate or have coated thereon a layer that helps distribute thermal energy in the thickness direction of the laminate material, for example, to help distribute heat either away or toward the skin direction of a user or wearer. Alternatively, or in addition, a thermally conductive material could help distribute thermal energy along the x-y plane of the laminate material, thereby improving the uniformity of absorption or release of thermal energy over a selected area.

[0077] Turning now to FIG. 7, an exemplary embodiment of a thermal moderating elastic laminate material having thermally conductive materials is illustrated in a highly stylized cross-sectional view. As shown in FIG. 7, the thermal moderating elastic laminate material 300 includes in this embodiment two extensible fibrous layers 310 and 320 sandwiching polymeric elastic layer 330. As illustrated in FIG. 7, the elastic laminate material 300 is configured in the form of the above-described stretch-bonded laminate wherein the fibrous layers 310, 320 are gathered layers. The fibrous layers 310, 320 may include any suitable fibrous material as previously described, for example a nonwoven material, and the polymeric elastic layer 330 may include any suitable elastic such as elastic films, nonwovens, strands, etc. One or both of extensible fibrous layers 310, 320 contains one or more thermal regulating additive(s).

[0078] Various suitable thermally conductive materials are known and may be used to promote the distribution or flow of thermal energy within or throughout the elastic laminate material. For example, in some embodiments, a metallic coating may be utilized to provide conductivity. Metals suitable for such a purpose include, but are not limited to, copper, silver, nickel, zinc, tin, palladium, lead, aluminum, molybdenum, titanium, iron, and so forth. Metallic coatings may be formed on any one or more of the laminate component materials, or portions thereof, using any of a variety of known techniques, such as vacuum evaporation, electrolytic plating, powder deposition, coating in liquid slurry or emulsion form, etc. For instance, U.S. Pat. No. 5,656,355 to Cohen; U.S. Pat. No. 5,599,585 to Cohen; U.S. Pat. No. 5,562,994 to Abba, et al.; and U.S. Pat. No. 5,316,837 to Cohen, which are incorporated herein in their entirety by reference thereto for all purposes, describe suitable techniques for depositing a metal coating onto a material.

[0079] In addition to one or more metallic coatings, or as an alternative thereto, other techniques may be employed to provide conductivity. For example, in one embodiment, an additive may be incorporated directly into a material (e.g.,
fibers of the extensible fibrous layer(s) 310, 320, or fibers, film, and/or strands of the polymeric elastic layer 330, etc.) to enhance thermal conductivity. Examples of such additives include, but are not limited to, carbon fillers, such as carbon fibers and powders; metallic fillers, such as copper powder, steel, aluminum powder, and aluminum flakes; and ceramic fillers, such as boron nitride, aluminum nitride, and aluminum oxide. Other commercially available examples of suitable conductive materials include, for instance, thermally conductive polymeric materials such as the polymers available from LNP Engineering Plastics, Inc. of Exton, Pa. under the name Konduit® or available from Cool Polymers of Warwick, R.I. under the name CoolPoly®. Although several examples of conductive materials have been described above, it should be understood that any known conductive material may be generally used.

[0080] Also shown in the illustration of FIG. 7 are exemplary “peaks” 340 and “valleys” 350, which are similar to the wrinkles 20 described with respect to FIG. 3. In particular, an emboident, a thermal moderating elastic laminate material having one or more thermally conductive materials might be constructed having the thermally conductive material located on or in substantially the entirety of one extensible fibrous layer or both. As an example, it may be desirable to construct a thermal moderating elastic laminate material having the thermal regulating additive located on a skin facing side, and the thermally conductive material located on the side of the thermal moderating elastic laminate material away from the skin. In this way, heat transfer can be promoted out of the thermal regulating additive and into the thermally conductive material, i.e. in the direction away from the wearer’s skin. Alternatively, the thermally conductive material may be beneficially located only in specific predetermined areas of one or more of the component layers. As an example, it may be desirable to locate the thermally conductive material substantially in the valley areas 350 of one or both of the extensible fibrous layers 310, 320.

[0081] As another example, it may be desirable to locate the thermally conductive material substantially in or on the polymeric elastic layer 350, or only in or on portions of the polymeric elastic layer. For example, consider a polymeric elastic layer including elastic strands and an elastic nonwoven material, e.g. an elastic meltblown material. For such a polymeric elastic layer, the thermally conductive material may desirably be located only in or on the elastic strands, thereby promoting heat transfer most directly at the points of direct contact with the extensible fibrous layer(s) having the thermal regulating additive, i.e., at the valley regions.

[0082] Furthermore, it should be noted that the constructional techniques used in forming the thermal moderating elastic laminate material may enhance heat transfer to and from the thermal regulating additive and generally within the thermal moderating elastic laminate material. For example, the component layers of the thermal moderating elastic laminate material may be laminated together by many means as are known in the art, for example by smooth calendering or by adhesive bonding the extensible fibrous layer(s) to the polymeric elastic layer. However, for the exemplary stretch-bonded laminate, smooth calendering and adhesion bonding of the extensible fibrous layer(s) to the polymeric elastic layer while the polymeric elastic layer is in its extended condition tend to form gatherings that are substantially randomly distributed across the surface of the material. In contrast, laminate bonding techniques such as spot (pattern) bonding or line bonding (either via thermal calendering or select deposition or placement of adhesives) can promote a gathering pattern that is relatively uniform, wherein a substantial number of the valleys of the fibrous materials align together or are “registered” such that the valley regions of each facing layer contact the polymeric elastic layer in the same place, thereby further promoting thermal energy transfer in the thickness direction of the laminate. In addition, it should be noted that although the thermal moderating elastic laminate material 300 shown in FIG. 7 has been described primarily with respect to an embodiment wherein the laminate is constructed as a stretch-bonded laminate material, other configurations as described above, such as the necked bonded laminate configuration, are possible.

[0083] Other embodiments and variations are also possible. For example, it may in some circumstances be desirable to add a thermally insulating material or layer of material to the thermal moderating elastic laminate material or elsewhere on the articles. Such insulating materials are well known in the art and include, by way of example, insulating fibrous webs, insulating waddings, and insulating closed cell and open cell foam materials. Such a thermal insulating material or material layer may be especially useful in circumstances where it is desired to provide the thermal moderating laminate or article to the user with the phase change material in its liquid phase state, such that the article or laminate will provide thermal energy to the skin of the user as it changes phase to the solid state. As still another example, it may in some circumstances be desirable to add a radiant heat barrier layer (or heat reflector) to the thermal moderating elastic laminate material or elsewhere on the articles. By way of example only, such radiant heat barrier layers include films, such as plastic films, foils, metalized foil films, and the like.

[0084] Another aspect of the invention encompasses other skin contact thermal moderating elastic articles. Exemplary forms of such skin contact thermal moderating elastic articles include article forms that do not strictly require the article to substantially envelop or encircle such as for example bed sheets and blankets providing thermal comfort or cooling to a user. Such skin contact thermal moderating elastic articles include a thermal moderating elastic laminate material having a polymeric elastic layer and extensible fibrous layer(s) as above, and include thermal regulating additive(s), and may include thermochromic pigment(s) and/or thermally conductive materials as described above. Such

[0085] While various patents have been incorporated herein by reference, to the extent there is any inconsistency between incorporated material and that of the written specification, the written specification shall control. In addition, while the invention has been described in detail with respect to specific embodiments thereof, it will be apparent to those skilled in the art that various alterations, modifications and other changes may be made to the invention without departing from the spirit and scope of the present invention. It is therefore intended that the claims cover all such modifications, alterations and other changes encompassed by the appended claims.

1. A thermal moderating donnable elastic article for enveloping a body part of a wearer, said thermal moderating donnable elastic article comprising a thermal moderating elastic laminate material, said thermal moderating elastic laminate material comprising at least one polymeric elastic layer and at
least one extensible fibrous layer laminated thereto, said at least one extensible fibrous layer comprising at least one thermal regulating additive.

2. The thermal moderating donnable elastic article as set forth in claim 1, wherein said thermal regulating additive is a phase change material.

3. The thermal moderating donnable elastic article as set forth in claim 1, wherein said extensible fibrous layer is a necked nonwoven material layer.

4. The thermal moderating donnable elastic article as set forth in claim 1, wherein said extensible fibrous layer is a gathered nonwoven material layer.

5. The thermal moderating donnable elastic article as set forth in claim 4, wherein said extensible fibrous layer is a necked and gathered nonwoven material layer.

6. The thermal moderating donnable elastic article as set forth in claim 4, wherein said extensible fibrous layer is a gathered nonwoven material layer.

7. The thermal moderating donnable elastic article as set forth in claim 6, wherein said second extensible fibrous layer is a gathered nonwoven material layer.

8. The thermal moderating donnable elastic article of claim 7 wherein said second extensible fibrous layer comprises a thermal regulating additive.

9. The thermal moderating donnable elastic article of claim 1 wherein said extensible fibrous layer is a carded web.

10. The thermal moderating donnable elastic article of claim 1 wherein said polymeric elastic layer comprises an elastic film layer.

11. The thermal moderating donnable elastic article of claim 1 wherein said polymeric elastic layer comprises elastic strands.

12. The thermal moderating donnable elastic article of claim 11 wherein said polymeric elastic layer comprises elastic melbown.

13. The thermal moderating donnable elastic article of claim 11 wherein said extensible fibrous layer is a gathered nonwoven material layer.

14. The thermal moderating donnable elastic article of claim 13, said thermal moderating elastic laminate material further comprising a second extensible fibrous layer laminated to the side of said polymeric elastic layer opposite said gathered nonwoven material layer.

15. The thermal moderating donnable elastic article of claim 1, said thermal moderating donnable elastic article further comprising at least one thermochromic pigment.

16. The thermal moderating donnable elastic article of claim 7, said thermal moderating donnable elastic article further comprising at least one thermochromic pigment.

17. The thermal moderating donnable elastic article of claim 13 said thermal moderating donnable elastic article further comprising at least one thermochromic pigment.

18. The thermal moderating donnable elastic article of claim 1 provided in the form of a glove, a headband, a body wrap, or a limb sleeve.

19. The thermal moderating donnable elastic article of claim 12 provided in the form of a glove, a headband, a body wrap, or a limb sleeve.

20. The thermal moderating donnable elastic article of claim 15 provided in the form of a glove, a headband, a body wrap, or a limb sleeve.

21. A thermal moderating elastic laminate material, said thermal moderating elastic laminate material comprising at least one polymeric elastic layer and at least one extensible fibrous layer laminated thereto, said at least one extensible fibrous layer comprising at least one thermal regulating additive, and said thermal moderating elastic laminate material further comprising a thermally conductive additive material.

22. The thermal moderating elastic laminate material of claim 21 wherein said at least one polymeric elastic layer comprises said thermally conductive additive material.

23. The thermal moderating elastic laminate material of claim 21 wherein said at least one extensible fibrous layer comprises said thermally conductive additive material.

24. The thermal moderating elastic laminate material of claim 21 wherein said thermally conductive additive material is selected from thermally conductive polymeric material additives, metal additives, carbon additives and ceramic additives.

25. A skin contact thermal moderating elastic article, said thermal moderating elastic article comprising a thermal moderating elastic laminate material, said thermal moderating elastic laminate material comprising at least one polymeric elastic layer and at least one extensible fibrous layer laminated thereto, said at least one extensible fibrous layer comprising at least one thermal regulating additive.