3-D FABRIC KNITTED STRETCH SPACER MATERIAL HAVING MOLDED DOMED PATTERNS AND METHOD OF MAKING

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ABSTRACT
A fabric having a face surface and a back surface forming a fabric plane, wherein the fabric is further processed to produce spaced apart, repeated patterned domes extending out of the fabric plane, the domes forming channels theretbetween, producing a molded formed 3-D fabric for evaporative cooling and/or insulation as well as comfort, stretch, compression resistance, decreased weight, and improved drape, softness, and/or conformability, depending upon the yarn component and fabric properties.
Figure 12

Yarn systems 1 & 2
1/40/24 poly
1/40 spandex

Yarn system 3
1/70/34 poly
1/177 monopoly
Figure 14

BK 3571

30" x 24" DK Spacer

REPEAT
Figure 15

BK 3595  30” x 24 cut DK Spacer

REPEAT

1/40 spandex & 1/40/24 poly
1 2 3 4 5 6 7 8

1/40/24 poly & 1/40 spandex
1 2 3 4 5 6 7 8

1/40 spandex & 1/40/24 poly
1 2 3 4 5 6 7 8

FEED #6 OUT OF ACTION

1/40 spandex & 1/40/24 poly
1 2 3 4 5 6 7 8

1/40/24 poly & 1/40 spandex
1 2 3 4 5 6 7 8

FEED #16 OUT OF ACTION

1/40 spandex & 1/40/24 poly
1 2 3 4 5 6 7 8

1/40/24 poly & 1/40 spandex
1 2 3 4 5 6 7 8

1/70/34 poly
1 2 3 4 5 6 7 8

1/177/1 mono
1 2 3 4 5 6 7 8
3-D FABRIC KNITTED STRETCH SPACER MATERIAL HAVING MOLDED DOMED PATTERNS AND METHOD OF MAKING

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This non-provisional utility patent application claims the benefit of one or more prior filed applications; the present application claims priority from U.S. provisional application Ser. No. 60/655,617 which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] (1) Field of the Invention

[0003] The present invention relates generally to textile products and, more particularly, to a 3-D fabric with domed shaped formed from a base “sandwich” material for providing cooling and/or insulation and improved stretch, compression resistance, decreased weight, and conformability and/or drape.

[0004] (2) Description of the Prior Art

[0005] U.S. Pat. No. 5,413,837 issued May 9, 1995 to Rock, et al. for Three-dimensional knit fabric teaches a three-dimensional knit or woven fabric that is permeable to water vapor but impermeable to liquid water is provided, including a first fabric layer, a second fabric layer and yarn interconnecting them, further including a barrier layer adhered to the outside surfaces, and the fabric being impermissively sealed.

[0006] U.S. Pat. No. 5,651,847 issued Jul. 29, 1997 to Loeffler for Double-face circular knit teaches a double face circular knit having two concentric lengths of knit web and an in-between spacer structure, wherein spacer threads are textured coarse-filament multifilament yarns, in combination with monofilament yarns.

[0007] U.S. Pat. No. 6,263,707 issued Jul. 24, 2001 to Miller, et al. for Opaque heat-moldable circular knit support fabrics having very high spandex content teaches a fabric and method including opaque heat-moldable circular knit fabrics having relatively high amounts of spandex material and other fibers to simultaneously provide maximum support and comfort to a wearer, wherein the fabric may be molded to the specifications of a wearer's body.

[0008] Prior art knitted spacer material commonly employs either warp-knitting or circular knitting techniques to produce a fabric having a predetermined thickness and bulk. However, the prior art knitted spacer materials typically have a relatively high weight, low stretch, and limited drape, since the fabric thickness and compressibility are factors that are generally optimized for a given application.

[0009] Thus, there remains a need for a 3-D fabric with domed shapes formed from a knitted spacer material having increased stretch and compression resistance, decreased weight, and improved drape as well as cooling and/or insulating properties.

SUMMARY OF THE INVENTION

[0010] The present invention is directed to a knitted stretch spacer material including the use of an elastomeric material such as SPANDEX for stretch and compression resistance without increasing weight, and improved conformability and/or drape. The present invention is further directed to a knitted spacer material further processed for particular applications, for example including mold-based forming and heat setting to provide a fabric having raised, shaped dimples or domes existing in a predetermined, repeated pattern wherein the domes protrude significantly above the fabric surface to provide a three-dimensional (3-D) channeled fabric for evaporative cooling and/or insulation, and comfort, in particular for applications as a layer of a garment, a liner material, or an underlayer beneath protective clothing or articles, such as, by way of example and not limitation, ballistic-protective wear, fire-protective wear, chemical- or radiation-protective wear, and the like. The present invention is still further directed to a method for making a knitted spacer material having high stretch, compression resistance, low weight, and improved drape or conformability with further processing steps to create the domed protrusions and garments or underlayers made therefrom.

[0011] Accordingly, one aspect of the present invention is to provide a knitted spacer material including a “sandwich” fabric having a face surface and a back surface in spaced apart relation with a body or filler portion constructed therebetween, and wherein the fabric is further processed to produce spaced apart, repeated patterned domes that form channels therebetween, producing a molded formed 3-D fabric. In embodiments where the fabric is used as a garment or portion of a garment, the fabric may further include a stretch yarn component for increased stretch and compression resistance of the material.

[0012] Another aspect of the present invention is to provide a 3-D dome-channeled knitted spacer material having different face and back surfaces, further including a secondary component, which may be applied as a coating, a lamination, and/or an infusion.

[0013] Still another aspect of the present invention is to provide a method for producing 3-D dome-channeled “sandwich” material, preferably formed from a knitted spacer material, in particular a circular knitted spacer material.

[0014] Still another aspect of the present invention is to provide a monofilament component fabric formed into a 3-D dome-channeled material for use as a garment or portion of a garment, such as a vest, for providing ventilation under protective equipment and/or clothing.

[0015] These and other aspects of the present invention will become apparent to those skilled in the art after a reading of the following description of the preferred embodiment when considered with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 illustrates an elevational view of the front of a shirt formed with a dimpled fabric in one embodiment of the present invention.

[0017] FIG. 2 illustrates an elevational view of the back of FIG. 1.

[0018] FIG. 3 illustrates a planar view of a portion of the shirt of FIG. 1 with a close-up on the dimpled area.
FIG. 4 illustrates a closer view of FIG. 3.

FIG. 5 illustrates another closer view of FIG. 3.

FIG. 6 illustrates a planar view of an underside portion of the shirt of FIG. 1.

FIG. 7 illustrates a closer view of FIG. 6.

FIG. 8 illustrates another closer view of FIG. 6.

FIG. 9 illustrates a perspective view of FIG. 6.

FIG. 10 illustrates a closer perspective view of FIG. 6.

FIG. 11 illustrates a perspective view of FIG. 6 (opposite side from FIG. 10).

FIG. 12 is a side cross-sectional view of a spacer material constructed according to the present invention.

FIG. 13 is a perspective view of an embodiment of the present invention.

FIG. 14 is a knitting pattern for manufacturing an embodiment of a spacer material constructed according to the present invention.

FIG. 15 is a knitting pattern for manufacturing another embodiment of a spacer material constructed according to the present invention.

FIG. 16 illustrates a cross-sectional view of a knitted stretch spacer material that is further processed via molding to produce 3-D, spaced apart domes in a repeated pattern, extending upward from one of either the face or back surface, produce a raised, domed surface pattern.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description, like reference characters designate like or corresponding parts throughout the several views. Also in the following description, it is to be understood that such terms as "forward," "rearward," "front," "back," "right," "left," "upwardly," "downwardly," and the like are words of convenience and are not to be construed as limiting terms.

Referring now to the drawings in general, the illustrations are for the purpose of describing a preferred embodiment of the invention and are not intended to limit the invention thereto.

The present invention provides a fabric having a face surface and a back surface forming a fabric plane, wherein the fabric is further processed to produce spaced apart, repeated patterned domes extending out of the fabric plane, the domes forming channels therebetween, producing a molded formed 3-D fabric, and methods of making the same. In embodiments where the fabric is used as a garment or portion of a garment, the fabric may further include a stretch yarn component for increased stretch and compression resistance of the material.

While FIGS. 1-2 illustrate a 3-D fabric used as a garment, the sandwich construction is preferably not used as a complete or full garment but as a partial garment such as an interior liner in vest, garments, protective clothing, protective components, etc.

FIGS. 1-11 illustrate 3-D fabric formed from predetermined, repeating pattern of domed shapes formed by molding the fabric between mating molds such that the domed shapes are formed as projections from the basic plane of the fabric or material before molding it. The domed shapes are provided in a predetermined, repeatable pattern: the domed shapes may be uniform or may vary in size and shape. The domed shapes may be selected from various cross-sectional shapes as from a top view, from circular to multi-sided, with rounded or sharper edges, including but not limited to substantially triangular, square, pentagonal, hexagonal, and so on, to 12-sided or more, as well as non-symmetrical shapes, including but not limited to logos and other symbols. Symmetrical shapes are preferred in most cases because they provide for uniform load distribution across the dome plateau or peak. In any case, the 3-D domed shapes protrude or extend beyond the base fabric plane to a predetermined height and angle for supporting the domed shape, depending upon the application.

Furthermore, the 3-D fabric provides for “breatheability” for cooling and/or insulating. Most significantly, the 3-D domed shapes produce channels therebetween that allow for air flow for evaporative cooling and/or insulating via the air traveling or flowing in the channels and/or being trapped therebetween. Also, the fabric body itself may include a predetermined permeability depending upon the fabric construction, yarn density, yarn type, and whether or not coatings, films, or other treatments are applied (such as in the case of an all-monofilament base fabric body, wherein the fabric air permeability is relatively high).

In preferred embodiments of the present invention, a “sandwich” material having a first side and a spaced apart, parallel second side is used as the base fabric prior to dome formation via additional processing of the material. More preferably, a knitted spacer material is used as the base fabric. As best seen in FIG. 12, a knitted spacer material or base fabric, generally referenced 10, is illustrated. The spacer material is preferably a 3-dimensional (3-D) material itself, i.e., 3-D within its own fabric plane, having an x-direction and y-direction forming a fabric plane and a z-direction that is orthogonal to the other directions, as shown in FIG. 13, i.e., forming a thickness (t) out of the fabric plane. The material includes at least two yarn systems, including a first yarn system and a second yarn system that are interlaced with a third yarn system to form a knitted material. FIG. 12 illustrates an embodiment according to the present invention having three yarn systems, a first yarn system 12, a second yarn system 14, and a third yarn system 16 formed of both monofilament and a multifilament or other yarn(s); the first and second yarn systems preferably include an elastomeric yarn component to provide stretch, such as SPANDEX. More specifically, the knitted material
has a face surface 18 (also shown in FIG. 13) and a back surface 20 with a body portion 22 of the material formed therebetween having a thickness measured between the two surfaces.

In one embodiment of the present invention, special yarns are selective used to provide enhanced functionality or added features to the fabric. By way of example but not limitation, a silver yarn may be used as part or all of one yarn system to provide natural antibacterial qualities. Alternatively, high strength yarns such as KEVLAR may be used for increased ballistic or penetration-resistance. Any fiber may be used within the “sandwich” fabric, depending upon the specific properties and performance requirements and the application of the fabric.

The body portion includes the third yarn system providing a compression resistant component substantially oriented in the z-direction or thickness direction of the material; while this component does extend in the x-direction and y-direction of the material as well, its main function is to provide the material properties in the z-direction or thickness by traversing between the face and back surfaces of the material, forming a zig-zag appearance when viewed from a side view as shown in FIG. 12. Importantly, according to a preferred embodiment of the present invention, at least this first yarn system includes an elastomeric or a stretch component for increased stretch of the material in both the x- and y-directions; preferably, the first and second yarn systems in an embodiment as shown in FIGS. 12 and 13, include an elastomeric or stretch yarn component. Surprisingly, the inclusion of the elastomeric or stretch component introduces a substantially increased compression resistance in the material in the z-direction or thickness dimension. The elastomeric synthetic material, or stretch component of the fabric preferably provides for an increased stretch between about 25%×25% in the x- and y-directions, respectively, to about 150%×200% in the x- and y-directions, respectively, more preferably about 100%×120% in the x- and y-directions, respectively. Surprisingly and significantly, it is important to recognize that this inclusion of the elastomeric or stretch yarn component in the first and second yarn systems has allowed the reduction of yarn size, including weight and stiffness, in the third yarn system which has allowed the material according to the present invention to perform to the desired objectives, as set forth in the foregoing, namely, to provide a knitted stretch spacer material including the use of an elastomeric or a stretch yarn component in predetermined levels to provide for stretch and compression resistance, without increasing weight, and improved drape and/or conformability that is further processed, including lamination and/or coating, to provide a liquid or vapor impermeable fabric, in particular for diving and wet suit applications. The conformability is qualitatively measured as the fabric’s ability to change direction and shape to conform to a user’s body, in particular when the fabric is incorporated into a garment or a portion of a garment or other bodily coverage. The knitted spacer material according to the present invention is formed with a face surface and a back surface in spaced apart relation with a body portion constructed therebetween, wherein the fabric further includes a stretch yarn component for increased stretch and compression resistance of the material, including after further processing, such as lamination and/or coating.

By way of specific design example, FIG. 16 illustrates a cross-sectional view of a single dome in a knitted stretch spacer material that is further processed via molding, specifically having molding in a male/female mold to produce 3-D, spaced apart domes in a repeated pattern, extending upward from one of either the face or back surface, produce a raised, domed surface pattern as shown in FIGS. 1-11.

In preferred embodiments, the knitted stretch spacer material includes a monofilament core wherein the yarn is between about 20 to about 400 denier, more preferably about 90 denier to optimize knitability, comfort, and compression-resistance.

In one embodiment, the knitted stretch spacer material is manufactured commercially by Beverly Knits, Inc. under the sample number BK 3595 Heavy at 22 oz/sq. yd. or under the sample number BK 3571 Light—19 oz/sq yd. having a non-laminated weights of 21 oz/sq. yd and 16.7 oz./sq. yd, respectively.

Furthermore, the material according to one embodiment of the present invention preferably has a thickness between about 2 mm to about 10 mm, more preferably between about 4 mm and about 6 mm prior to further processing to create the 3-D formed domed channeled material, which increases the overall thickness of the fabric by the dome height. Preferably, for garment, liner, underlayer applications and the like, a range of dome heights may be from at least equivalent to the fabric thickness, preferably greater, and more preferably 2x to 20x, which produces larger channels for cooling and/or insulating and/or providing additional body protection, such as penetration avoidance due to the protruding shape, stand-off or dome height. The drape of the fabric prior to molding or dome formation, as well as afterward, is further characterized as being a conformability factor, i.e., the capacity of the material or fabric to adapt to curvature, more particularly, to change direction and shape to conform to a user’s body, in particular when the fabric is incorporated into a garment or a portion of a garment or other bodily coverage. The sandwich material or fabric described herein is uniquely suited to provide comfort due to drape and surface qualities, as well as shape retention, in particular substantial retention of the molded dome shape and dimensions to preserve the air channeling functionality when worn beneath other garments, specifically protective garments having substantial weight. By contrast, significantly lighter weight, non-sandwich materials do not provide both benefits simultaneously.

Preferably, the knitted spacer material is formed of synthetic fibers in at least one of the yarn systems. Furthermore, in a preferred embodiment of the present invention, monofilament is used in at least one of the yarn systems, preferably in the third yarn system. Importantly, the monofilament component provides for additional improvement for compressibility and recovery as well as reducing the overall weight of the material. The compressibility and recovery properties of the present invention make it well-suited for impact dispersion applications.

By contrast, a prior art material manufactured from a warp-knit structure has significantly less stretch in the x- and y-directions than the present invention, as well as being thinner in the z-direction and being an overall heavier fabric per linear square unit. Note however, that some warp knitted
materials may be manufactured at higher thicknesses, depending upon the specifications and/or desired characteristics of the fabric in a particular application, as is apparent to one of ordinary skill in the art.

[0048] FIG. 13 illustrates another side view of an alternative embodiment according to the present invention, having modified properties, in particular affecting the stretch and/or compression resistance and recovery of the material.

[0049] While preferably, the present invention is a circular knit material, a warp-knit material may also be produced according to the present invention as set forth hereinabove without departing from the scope and spirit of the invention.

[0050] FIGS. 14 and 15 show knitting pattern examples used in methods for manufacturing the knitted stretch spacer material according to the present invention. In particular, FIG. 14 shows a knitting pattern for a basic welt knit spacer material having a predetermined density and number of ends per centimeter. The elastomeric or stretch yarn component was added in this knitting design to at least one of the yarn systems for providing increased stretch and recovery properties in the finished material. Without making any modifications to the yarn densities and/or knitting, the overall material weight increased upon the addition of a stretch yarn component. Surprisingly, and after much experimentation, the knitting pattern shown in FIG. 15 was adapted to manufacture a knitted stretch spacer material according to the present invention wherein up to about a 50% reduction in monofilament yarns were required to be employed in the yarn system(s) of that embodiment, while providing a finished material having approximately equal or improved stretch and recovery, drape and/or conformability, and similar compression resistance to the embodiment shown in FIG. 14 while decreasing the overall material weight by comparison. The number of courses per inch and wales per inch of the knitted structure were higher and provided increased fabric density. Therefore, the present invention provides a method of manufacturing a knitted stretch spacer material by incorporating a stretch yarn component and reducing the monofilament component(s) by up to about 50%, while retaining compression resistance, and providing improved stretch and recovery, drape and/or conformability, and overall decreasing the material weight. A method of manufacturing a knitted spacer material including the steps of: providing at least two yarn systems for interconnecting via a knitting pattern, wherein at least one of the at least two yarn systems includes a stretch yarn component and at least one of the at least two yarn systems includes a monofilament component; knitting the stretch yarn component according to the pattern, which permits the elimination of up to about 50% of the monofilament weight of a standard, non-stretch spacer fabric without a stretch yarn component, while providing for comparable stretch and compression resistance, decreased weight, and increased conformability of the spacer material compared to the standard, non-stretch spacer fabric. Note that, while most knitted structures provide for some stretchability, non-stretch fabric, as used in the foregoing description refers to a knitted fabric having stretch limited substantially to that stretch provided by the knitting pattern itself, and not due significantly to the yarn components used in manufacturing the spacer material or fabric. Additional or further steps of processing include: providing corresponding male and female mating mold components for forming the 3-D domes in predetermined, repeating patterns in the fabric; inserting the fabric between the molds; closing molds together with the fabric therebetween to produce dome shapes protruding from the fabric plane; providing adequate, predetermined pressure and/or temperature for setting the dome shapes in the fabric; removing the fabric from the molds after a predetermined dwell time, which is preferably between about 15 seconds to about 10 minutes, more preferably between about 1 to about 5 minutes, wherein longer dwell times typically correspond to stiffer and higher dome shapes. Methods disclosed in the prior art applicable for forming the domed shapes include, for example, U.S. Pat. Nos. 5,713,062; 6,007,898; 5,833,321; 5,851,930; 5,896,680; 5,882,322; 5,972,477; which are used for forming knitted or woven fabrics made entirely of monofilament yarns, all of which are incorporated herein by reference in their entirety, being cited not as the present invention but for providing enabling disclosure supporting the present invention as set forth herein.

[0051] In another preferred embodiment, monofilament yarn components are interconnected to form a fabric that is further processed to create 3-D dome-channeled material for use as a garment or portion of a garment, such as a vest, for providing ventilation under protective equipment and/or clothing. Preferably, the monofilament is at least about 100 denier monofilament to provide sufficient stiffness and porosity for cooling and ventilation via channels between the 3-D fabric domes as well as through the plane of the fabric and domes directly, i.e., at substantially perpendicular direction to the channels. Thus, the fabric provides for breathability via fabric permeability as well as via channels to allow for evaporative cooling, or passive cooling. The fabric may be used as a liner for new garments and be interconnected at seams or other predetermined locations so as to provide a single garment, or as a liner that may be retrofit or attached to existing garments. In the latter case, the lining may be provided in the form of one or more panels that substantially fit under sections or portions of the garment, but are not made to exactly line or match the garment itself. These panels may be removable and attachable in predetermined locations to the garment, for example by fasteners, hooks, buttons, hook-and-loop type fasteners, and the like, and combinations thereof.

[0052] Additional steps may be included for coupling or connecting (removably or permanently affixing) the fabric to a protective device or component such as a vest or garment lining, or cutting and sewing or otherwise connecting bonding the fabric segments to form a garment or a partial garment.

[0053] Other embodiments may include liners for back packs, or other sporting equipment, such as protective guards or padding, including but not limited to soccer shin guards, football protective wear, helmets, knee pads, elbow pads, and the like.

[0054] Certain modifications and improvements will occur to those skilled in the art upon a reading of the foregoing description. In particular, the knitted spacer material may function as a carrier or substrate, wherein additional processing provides additional and/or supplemental functionality not inherently present in the material itself. By way of example, the present invention may be further processed, e.g., by lamination or coating the fabric, where fabric permeability is not desirable or needed to be maximized.
Additionally or alternatively, the knitted spacer material may be infused with another substance, such as a medication, for use as a bandaging material capable of releasing a medication at the location of its application, e.g., directly to a wound in a bandage application. Certain coatings can be applied to this spacer fabric to achieve different benefits and/or fabric characteristics or properties. Films applied to either side for moisture barriers or to enhance wicking. By way of example and not limitation, a phase change material may be applied to provide thermal management properties, such as temperature resistance, fire retardants, antimicrobial coatings or yarns may be used to manage, control, or limit bacterial growth. Seaming, sealing, or other edge processing, e.g., by way of example and not limitation, overedge sealing, ultrasonic or RF welding, or seaming, may also be advantageously included in additional processing, depending upon the application for the material.

Also, the 3-D fabric including a “sandwich” or spacer material may further function in some applications as a carrier of medicines like anti-clotting drugs etc. The fabric is capable of incorporating antibacterial products like silver or other chemical treatments. Also the fabric may have wicking treatments applied either topical or impregnated into the yarns. Any yarns can be used on either side including, aramid yarns like the commercially available KEVLAR, NOMEX, and others, natural fibers like cotton, wool, etc. man made fibers like polyester, nylon, polypropylene and others. The middle “sandwich” yarn can be made of other fibers also, nylon, polyester, polypropylene, all that can be formed with temperature and pressure.

All modifications and improvements have been deleted herein for the sake of conciseness and readability but are properly within the scope of the present invention.

DESIGN EXAMPLE(S)

This section outlines a few design examples, not necessarily optimized, but illustrative of what can be done for a knitted spacer material according to the present invention and method of manufacturing the same. These design examples include the following:

Example 1

In this preferred embodiment of the knitted spacer material as shown in FIG. 12 and having a knitting pattern shown in FIG. 14, the material was formed using the following components:

In the first yarn system direction, a Polyester yarn type of 40 denier was used in combination with a 40 denier spandex yarn; in the second yarn system, a Polyester yarn type of 40 denier was used in combination with a 40 denier spandex yarn; in the third yarn system, a Polyester yarn type of 177 denier monofilament was used in combination with a 70 denier polyester yarn. The machine set up included the following parameters: A double knit machine with a dial height variance up to 250 thousands separation from the cylinder, utilizing spandex feeder to plait spandex on the dial only and cylinder only feeds. Requirements include facilities to implement monofilament yarn into the knitting elements with controlled measurement of amount to minimize tension and improve knitting of monofilament yarn such that it does not poke thru the face and back of finished product.

Further information relating to the sample includes:

Laminated One Side—BK 3595 Heavy—22 oz/sq. yd, BK 3571 Light—19 oz/sq yd.

Unlaminated BK 3595 Heavy—21 oz/sq yd, BK 3571 Light—16.7 oz/sq yd.

Knits specs the Unlaminates at 22.9 and 18 oz respectively, so we start from different baselines.

Summary: Beneficial low spacer weight material.

Elasticity/Modulus (prior to dome channel formation):

As a matter of comparison to baseline:

One Side BK 3595 Heavy—elasticity and modulus are in the 30% and 150% range, respectively, of original un laminated measurements. The original numbers were Desirable to Very Desirable for elasticity and Desirable for modulus. One Side BK 3571 Light—elasticity and modulus are in the 50% and 200% range, respectively, of original un laminated measurements. The original numbers were Desirable for elasticity and Very Desirable for modulus.

Permeability

Water impermeability before and after bonding tests was Very Desirable.

Surprisingly, the introduction of 10% SPANDEX yarn in the yarn component system(s) required much experimentation with the machine set-up, wherein a setting of 17% was required for the material to be produced and reproduced consistently, providing the following material properties:

By increasing the spandex percentages and reducing the yarn sizes, the results created a fabric with the third yarn system in an almost vertical plane. This is most important to achieve the compression resistances of the require applications. This surprise allowed the reduction of monofilament used in the fabric to be decreased by almost 50%. The results thus produced fabrics of preferred weight variations, stretches and thickness.

BK 3595 Light; 17% spandex; 18.00 ounces per square yard weight; 100% lengthx150% width stretch, 6 mm thick.

BK 3595 Heavy; 17% spandex 22 ounces per square yard weight; 120% widthx200% length stretch, 6 mm thick.

BK 3571 Light; 10% spandex; 18.00 ounces per square yard weight; 80% lengthx90% width stretch, 5 mm thick.

BK 3571 Heavy; 10% spandex 28 ounces per square yard weight; 90% widthx160% length stretch, 6 mm thick.

Certain modifications and improvements will occur to those skilled in the art upon a reading of the foregoing description. All modifications and improvements have been deleted herein for the sake of conciseness and readability but are properly within the scope of the following claims.

1. A three-dimensional fabric for insulating and/or cooling comprising

a knitted spacer material, the material further comprising:

a face surface;

a back surface in spaced apart relation to the face surface; and
a body portion constructed therebetween forming a unitary, integrally constructed material within a first material plane;

wherein material is formed into patterned domed shapes projecting out of the first material plane.

2. The three-dimensional fabric of claim 1, wherein the domed shapes are provided in a predetermined, repeatable pattern.

3. The three-dimensional fabric of claim 1, wherein the domed shapes are substantially uniform in shape.

4. The three-dimensional fabric of claim 1, wherein the domed shapes vary in size and/or shape.

5. The three-dimensional fabric of claim 1, wherein the domed shapes are circular or oval in shape.

6. The three-dimensional fabric of claim 1, wherein the domed shapes are multi-sided in shape.

7. The three-dimensional fabric of claim 1, wherein the multi-sided domed shapes have rounded edges.

8. The three-dimensional fabric of claim 1, wherein the multi-sided domed shapes have sharp edges.

9. The three-dimensional fabric of claim 1, wherein the said multi-sided domed shapes have cross-sectional shapes selected from the group consisting of round, triangular, square, pentagonal, hexagonal, octagonal.

10. The three-dimensional fabric of claim 1, wherein the domed shapes have non-symmetrical shapes.

11. The three-dimensional fabric of claim 1, wherein the domed shapes produce channels therebetween.

12. The three-dimensional fabric of claim 1, wherein the domed shapes protrude beyond the base fabric plane to a predetermined height and angle.

13. The three-dimensional fabric of claim 12, wherein the height of the domes is at least equivalent to or greater than the thickness of the said fabric.

14. The three-dimensional fabric of claim 12, wherein the height of the domes range between 2-20 times the thickness of the said fabric.

15. The three-dimensional fabric of claim 1, wherein the fabric is formed of three yarn systems: a first yarn system constituting the said face surface; a second yarn system constituting the said back surface; and a third yarn system constituting the said body portion.

16. The three-dimensional fabric of claim 15, wherein at least one of the said three yarn systems includes an elastomeric yarn component.

17. The three-dimensional fabric of claim 15, wherein at least one of the said three yarn systems includes a monofilament yarn component.

18. The three-dimensional fabric of claim 15, wherein at least one of the said three yarn systems includes a multifilament yarn component.

19. The three-dimensional fabric of claim 15, wherein at least one of the said three yarn systems includes a high strength yarn component.

20. The three-dimensional fabric of claim 1, wherein the knitted spacer material includes a monofilament core.

21. The three-dimensional fabric of claim 1, wherein the fabric further comprises a secondary component, with said secondary component being applied to the fabric as a lamination.

22. The three-dimensional fabric of claim 1, wherein the fabric further comprises a secondary component, with said secondary component being applied to the fabric as a coating.

23. The three-dimensional fabric of claim 22, wherein said secondary component includes at least one moisture barrier.

24. The three-dimensional fabric of claim 22, wherein said secondary component includes at least one phase change material.

25. The three-dimensional fabric of claim 22, wherein said secondary component includes at least one antimicrobial agent.

26. The three-dimensional fabric of claim 1, wherein the fabric further comprises a secondary component, with said secondary component being applied to the fabric as an infusion.

27. The three-dimensional fabric of claim 22, wherein said secondary component includes at least one medication.

28. The three-dimensional fabric of claim 22, wherein a sandwich-like material having a first side; and a spaced apart, parallel second side is used as a base fabric, with said base fabric being processed to produce the said three-dimensional fabric having plurality of domed shapes.

29. The three-dimensional fabric of claim 28, wherein the said sandwich-like material has a thickness ranging between about 2 mm and about 10 mm prior to further processing to create the three dimensional fabric.

30. The three-dimensional fabric of claim 28, wherein said processing of the base fabric is provided via molding.

31. The three-dimensional fabric of claim 1, wherein said fabric is used as a liner for protective garments and/or equipment.

32. The three-dimensional fabric of claim 1, wherein said fabric is used as a liner for a garment.

33. The three-dimensional fabric of claim 1, wherein said fabric is used as a liner for at least one part of a garment.

34. The three-dimensional fabric of claim 1, wherein the fabric is used as a carrier for a secondary component including at least one medication.

35. The three-dimensional fabric of claim 1, wherein at least one wicking treatment is topically applied to the fabric or impregnated in at least one of the yarn components.

36. A three-dimensional fabric, having a plurality of domed shapes, comprising monofilament yarn components interconnected to form a base fabric, which is thereafter formed into a 3-D dome-channeled material for use as a garment or portion of a garment for providing ventilation under protective equipment and/or clothing.

37. A method of manufacturing a three-dimensional fabric, formed from a knitted spacer material, and having a plurality of domed shapes, including the steps of:

- providing at least two yarn systems for interconnecting via a knitting pattern, wherein at least one of the at least two yarn systems includes a stretch yarn component and at least one of the at least two yarn systems includes a monofilament component;

- knitting the stretch yarn component according to a predetermined pattern;

- providing corresponding male and female mating mold components for forming three dimensional domes in predetermined, repeating patterns in the fabric;

- inserting the fabric between the molds;

- closing molds together with the fabric there-between to produce dome shapes protruding from the fabric plane;
providing adequate, predetermined pressure and/or temperature for setting the dome shapes in the fabric; and removing the fabric from the molds after a predetermined dwell time.

38. The method of claim 37, wherein the said predetermined dwell time ranges preferably between about 15 seconds and about 10 minutes, and more preferably between about 1 minute and about 5 minutes.

39. The method of claim 37, further including additional steps by which the manufactured three dimensional fabric is cut and sewed to form a garment, or at least a portion of a garment.

40. The method of claim 37, further including additional steps by which a secondary component being applied to the fabric as a lamination or a coating.