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(54) **COOLING MATERIAL FOR BODYWEAR**

KÜHLMATERIAL FÜR OBERKLEIDUNG

MATÉRIAU RAFRAICHISSANT POUR VÊTEMENT DE CORPS

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(56) References cited:

EP-A2- 1 894 482 WO-A1-2012/136962
WO-A1-2013/044108 WO-A2-2006/020213
JP-A- 2009 185 420 US-A1- 2003 208 831
US-A1- 2007 163 027 US-A1- 2012 190 259
US-B1- 7 842 625

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Description

Technical Field

[0001] Embodiments of the present disclosure relate generally to fabrics used for apparel having enhanced cooling properties, and in particular to fabrics that utilize absorbent polymer elements coupled to a wicking base fabric to enhance cooling.

Background

[0002] Performance fabric materials such as wicking materials and cooling materials typically take the form of uniform layers that are woven into or otherwise incorporated into the interior of a garment. Cooling fabrics that incorporate a layer of cooling materials such as highly absorbent polymers have shortcomings, particularly when incorporated into the fabric as a continuous layer. For example, a uniform layer of polymer material may impede the transfer of moisture vapor or restrict air passage through the fabric. Furthermore, such cooling materials may impede a desired characteristic of the base fabric, such as drape, texture and stretch. Thus, the use of a layer of cooling material may impede the breathability (or another function) of the underlying base fabric.

[0003] EP 1894 482 A2 relates to textile fabrics which are responsive to change in moisture or temperature, which includes a smooth surface with one or more regions having a bound coating of hydrogel exhibiting expansion or contraction in response to change in relative humidity or exposure to liquid sweat. According to an aspect of the fabric described in this prior art document, a temperature and moisture responsive textile fabric garment includes a thermal fabric having a smooth outer surface, and a plurality of discrete regions of hydrogel disposed in a pattern corresponding to one or more predetermined regions of a user's body and bound to the smooth outer surface of the thermal fabric. The hydrogel exhibits expansion or contraction in response to change in relative humidity or exposure to liquid sweat, adjusting insulation performance, air movement or liquid management of the textile fabric.

[0004] US 2003/0208831 A1 discloses a cooling garment constructed, at least in part, of a cooling fabric. The cooling fabric includes an upper layer that includes a water-resistant fabric, a lower layer that includes a water-resistant fabric, a plurality of chambers disposed between the upper layer and the lower layer. The upper layer and the lower layer are connected by stitching using a water wickable thread, and a superabsorbent polymer is contained within a majority of the chambers.

[0005] WO 2013/044108 A1 discloses a fabric or other material used for apparel and other goods having designed performance characteristics. It discloses also methods and apparatuses that utilize a pattern of performance elements coupled to a base fabric to manage one or more performance characteristics while maintain-

ing the desired properties of the base fabric.

[0006] A first array of performance elements directs or absorbs or emits heat, wicks moisture, or a combination thereof and a second array of second performance elements coupled to the base material in a second zone performs a second function comprising directing or absorbing heat or wicking moisture, or a combination thereof. In one particular embodiment, the first array comprises a heat directing polymer and the second array comprises a cooling polymer.

Brief Description of the Drawings

[0007] Embodiments of the present disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings. Embodiments are illustrated by way of examples.

Figures 1A-1D show several perspective views of one example of a cooling material having a base fabric with a high moisture wicking rate and a discontinuous pattern of highly absorbent polymer elements disposed thereon, including a view of moisture contacting one portion of the base fabric (**Figure 1A**), a view of the base fabric dispersing the moisture over a large surface area via a wicking action (**Figure 1B**), a view of the highly absorbent polymer elements absorbing moisture from the base fabric (**Figure 1C**), and a view of the moisture evaporating from the absorbent polymer elements (**Figure 1D**), in accordance with various embodiments;

Figures 2A-2H illustrate a variety of specific examples of patterns of individual highly absorbent polymer elements in accordance with various embodiments;

Figures 3A-3F illustrate a variety of specific examples of patterns of interconnected highly absorbent polymer elements, in accordance with various embodiments; and

Figures 4A and **Figure 4B** show a comparison of the efficacy of a control cooling polymer fabric (**Figure 4A**) versus a new cooling material (**Figure 4B**) having a base fabric with a high moisture wicking rate, and a highly absorbent polymer element disposed thereon, in accordance with various embodiments.

Detailed Description of Embodiments

[0008] In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which are shown by way of illustration embodiments in which the disclosure may be practiced. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the claims.

[0009] Various operations may be described as multiple discrete operations in turn, in a manner that may be

helpful in understanding embodiments of the present disclosure.

[0010] The description may use perspective-based descriptions such as up/down, back/front, and top/bottom. Such descriptions are merely used to facilitate the discussion.

[0011] The terms "coupled" and "connected," along with their derivatives, may be used. It should be understood that these terms are not intended as synonyms for each other. Rather, in particular embodiments, "connected" may be used to indicate that two or more elements are in direct physical contact with each other. "Coupled" may mean that two or more elements are in direct physical contact. However, "coupled" may also mean that two or more elements are not in direct contact with each other, but yet still cooperate or interact with each other.

[0012] For the purposes of the description, a phrase in the form "A/B" or in the form "A and/or B" means (A), (B), or (A and B). For the purposes of the description, a phrase in the form "at least one of A, B, and C" means (A), (B), (C), (A and B), (A and C), (B and C), or (A, B and C). For the purposes of the description, a phrase in the form "(A)B" means (B) or (AB) that is, A is an optional element.

[0013] The description may use the phrases "in an embodiment," or "in embodiments," which may each refer to one or more of the same or different embodiments. Furthermore, the terms "comprising," "including," "having," as used with respect to embodiments of the present disclosure, are synonymous.

[0014] In various embodiments, cooling materials for clothing and other body gear are disclosed that may use a discontinuous pattern (whether interconnected or having independent elements) of highly absorbent polymer elements coupled to a body-facing surface of a base fabric that has a low resistance to moisture spread (e.g., a high wicking rate). In various embodiments, the highly absorbent polymers may leave portions of the base fabric exposed, for example, areas of the base fabric may be left uncovered between or among the highly absorbent polymer elements. Additionally, the highly absorbent polymer elements may be significantly more absorbent than the base fabric, such as two, three, four, five, or even ten or more times more absorbent. In various embodiments, the cooling materials may be used to manage moisture (e.g., sweat) and body heat.

[0015] In various embodiments, when the cooling material is exposed to moisture, the base fabric may quickly wick the moisture away from the skin. The moisture may then be dispersed through/along the base fabric over a wide surface area via a wicking action, and the highly absorbent polymer elements may begin absorbing moisture, both from the base fabric and directly from the skin. In various embodiments, this process may cause a redistribution of moisture, first from a localized area of the base fabric to a larger area of the base fabric, and then from the base fabric into the highly absorbent polymer elements.

[0016] Thus, in various embodiments, by spreading

the moisture over a large surface area of the base fabric, and by drawing the moisture from the base fabric into the highly absorbent polymer elements, evaporation from the base fabric may be facilitated, which may accelerate the evaporative cooling experienced by the wearer. Additionally, in various embodiments, once the highly absorbent polymer elements have absorbed moisture from the base fabric, they may retain the moisture close to the skin surface and produce a prolonged evaporative cooling sensation for the user, for example when compared to that produced by the base fabric alone. In various embodiments, the highly absorbent polymer elements, and the uncovered portions of base fabric therebetween, may permit the base fabric to retain certain desired characteristics, such as stretch, drape, breathability, moisture vapor transfer, air permeability, and/or wicking.

[0017] For the purposes of the present description, the term "discontinuous pattern of highly absorbent polymer elements" includes an ordered or disordered pattern of independent elements, a matrix of interconnected elements, or a hybrid of both, with portions of the base fabric left exposed and uncovered by the elements between or amongst the discontinuous pattern. As used herein, the term "absorbance" refers to the ability of a fiber or a polymer to absorb moisture, for example by diffusion. Absorbance typically is expressed as a percentage of weight of the starting material. By contrast, as used herein, the term "wicking" or "wickability" refers to the movement of bulk fluid along or between fibers, for example in a fabric or other textile. As such, a fabric or other textile may have both a high wicking rate and low absorbance.

[0018] As used herein, the term "endothermic" as applied to a process refers to a process in which the system absorbs energy from its surroundings in the form of heat. As applied to a fabric or composition, the term "endothermic" as used herein refers to a fabric or composition that absorbs heat from its surroundings, for instance upon a change of state or upon absorbing water or other fluids. For an endothermic reaction, ΔH (the change in enthalpy) is greater than zero.

[0019] Figures 1A-1D show several perspective views of one example of a cooling material having a base fabric with a high moisture wicking rate and a discontinuous pattern of highly absorbent polymer elements disposed thereon, including a view of moisture contacting one portion of the body-facing side of the base fabric (**Figure 1A**), a view of the base fabric dispersing the moisture over a large surface area via a wicking action (**Figure 1B**), a view of the highly absorbent polymer elements absorbing moisture from the base fabric (**Figure 1C**), and a view of the moisture evaporating from the absorbent polymer elements through the base fabric and away from the body (**Figure 1D**), in accordance with various embodiments. In various embodiments, a cooling material **100** may include a plurality of highly absorbent polymer elements **104** disposed on a base fabric.

[0020] Thus, in various embodiments, the base fabric **102** may have a high moisture wicking rate and a low

absorbance compared to the absorbance of the highly absorbent polymer elements **104**. Wicking rate may be measured using any of a variety of tests known to those of skill in the art. For instance, one measure involves determining the distance a fixed volume of moisture spreads from an emanation point when dropped onto the surface of a fabric. Generally, the greater the distance the moisture travels from the emanation point, the stronger the "wickability" of the fabric. Other suitable tests of wicking rate include the Vertical Wick Test (e.g., AATCC 197) and the moisture management test (MMT). As defined herein, a fabric having a "high wicking rate" wicks at least three inches in ten minutes as measured using the Vertical Wick Test (AATCC 197).

[0021] Absorbance is also easily determined in a laboratory setting. In various embodiments, for example, when measured with a moisture sorption balance at 30°C and 80% relative humidity, the base fabric **102** may absorb about 0 - 2.0% of its weight in moisture, such as about 0.25 - 1.5%, about 0.5 - 1.0%, or about 0.8%. In various embodiments, by contrast, when measured with a moisture sorption balance at 30°C and 80% relative humidity, the highly absorbent polymer elements **104** may absorb about 3.0 - 20% of their weight in moisture, such as about 3.3%, about 5.0%, or about 10%. In some embodiments, the highly absorbent polymer elements **104** may absorb even more moisture, such as about 50% or even 100% of their weight in water.

[0022] In various embodiments, the highly absorbent polymer elements **104** may be several fold more absorbent than the base fabric **102**, such as about 2X, 3X 4X 5X, 10X, 20X, 50X, 100X, 200X, or even 300X (or more) as absorbent than the base fabric **102**. For example, in one specific example, the highly absorbent polymer elements **104** may absorb about 3.3% moisture by weight as measured under the conditions listed above, whereas the base fabric **102** may absorb only about 0.8% moisture by weight, making for about a four-fold difference in absorbance between the base fabric **102** and the highly absorbent polymer elements **104**. Without being bound by theory, it is believed that this absorbance differential between the base fabric **102** and the highly absorbent polymer elements **104** pulls moisture from the base fabric **102** into the highly absorbent polymer elements **104**, thus enhancing evaporative cooling and creating a sensation of dryness in the base fabric **102**.

[0023] In various embodiments, the highly absorbent polymer elements **104** may be disposed in a generally discontinuous array or pattern, whereby some of the base fabric **102** may be exposed within or between adjacent highly absorbent polymer elements **104**. In various embodiments, the highly absorbent polymer elements **104** may be arranged in an array of separate elements, whereas in other embodiments, discussed at greater length below, the highly absorbent polymer elements **104** may be arranged in an interconnected pattern. In some embodiments, a highly absorbent polymer element may take the form of a solid shape or closed loop member,

such as a circle, square, hexagon, or other shape. In other embodiments, the discontinuous pattern of highly absorbent polymer elements **104** may take the form of a lattice, grid, or other interconnected pattern.

[0024] As illustrated in **Figures 1A** and **1B**, the highly absorbent polymer elements **104** are positioned on the surface of the base fabric **102** facing the wearer's skin, and as moisture **106** contacts the base fabric **102** (**Figure 1A**) (for instance, in the form of sweat from the skin of the wearer), it begins to spread and disperse laterally through the base fabric **102** (**Figure 1B**) due to the base fabric's high moisture wicking rate and low resistance to moisture spread. In some embodiments, the base fabric **102** may be treated with a hydrophilic compound in order to increase its moisture wicking rate or a hydrophobic compound to assist in movement of moisture in a desired direction. The base fabric's lower absorbance (compared to that of the highly absorbent polymer elements **104**) also permits the moisture to travel freely within the cooling material **100**.

[0025] As illustrated in **Figure 1C**, moisture may then contact the highly absorbent polymer elements **104** and may begin to be absorbed, enhancing evaporative cooling through the base fabric **102** and creating a sensation of dryness for the user. For example, in some embodiments, the highly absorbent polymer elements **104** pull moisture from the surrounding base fabric **102**, causing accelerated evaporation and allowing the base fabric **102** to dry quickly, for example more quickly than base fabric **102** dries without highly absorbent polymer elements **104**. During this process, the highly absorbent polymer elements **104** absorb moisture from the base fabric **102**, and this redistribution of the moisture is facilitated both by the absorbance properties of the highly absorbent polymer elements **104** and the base fabric's low resistance to moisture spread and lower absorbance when compared to the highly absorbent polymer elements **104**. This redistribution of the moisture from the base fabric **102** to the highly absorbent polymer elements **104** accelerates evaporative cooling from the base fabric **102** (and thereby the skin of the user), and also prepares the cooling material **100** for more prolonged cooling.

[0026] In various embodiments, moisture may have a higher equilibrium concentration in the highly absorbent polymer elements **104** than it has in the base fabric **102**. Without being bound by theory, it is believed that this difference in absorbance levels may create a concentration gradient within the cooling material **100** as the highly absorbent polymer elements **104** absorb moisture from the base fabric **102**. In various embodiments, the moisture concentration gradient drives moisture out of the base fabric **102** and into the highly absorbent polymer elements **104**. As the highly absorbent polymer elements **104** absorb moisture from the base fabric **102**, the base fabric **102** is then capable of absorbing more moisture, such as perspiration from the body.

[0027] As illustrated in **Figure 1D**, moisture retained in the highly absorbent polymer elements **104** causes

prolonged evaporation, pulling moisture in a direction away from the skin of the wearer (see arrows) until the cooling material **100** returns to a dry state, in accordance with various embodiments. During this phase of cooling, the base fabric **102** may be largely dry, and most of the cooling function of the cooling material **100** may be provided by evaporation from the highly absorbent polymer elements **104** during the prolonged cooling phase. In various embodiments, positioning the highly absorbent polymer elements **104** against (or next to) the skin of the wearer may help the wearer to experience a sensation of prolonged evaporative cooling. For example, evaporation from the highly absorbent polymer elements **104** causes a reduction in the temperature of the cooling elements **104** in much the same way that evaporation from the skin surface cools the skin. Thus, in various embodiments, positioning the cooler highly absorbent polymer elements **104** on the body-facing surface of the base fabric **102** allows the wearer to perceive this cooling sensation, whereas the cooling sensation may be less noticeable if the highly absorbent polymer elements **104** were positioned on the outward-facing surface of the base fabric **102**. In some embodiments, the cooling fabrics disclosed herein may provide a cooling phase, defined as the period of cooling resulting from evaporation of a particular quantity of liquid/sweat, that lasts 110%, 120%, 150%, 200% (or even more) as long as the cooling phase provided by the base fabric alone.

[0028] Prior to the present disclosure, it was widely believed that positioning the cooling elements on the outward-facing surface of the base fabric **102** would produce a superior cooling effect, as this arrangement allows for evaporation from the highly absorbent polymer elements **104** to proceed unencumbered by the base fabric **102**. However, as disclosed herein, it has now been found that positioning the highly absorbent polymer elements **104** on the body-facing surface of the base fabric **102** enhances the coolness sensation perceived by the wearer, while still allowing moisture to evaporate and a steady rate through the base fabric **102**.

[0029] As described below in greater detail, the highly absorbent polymer elements **104** may include one or more hygroscopic polymers, such as a polymer that may absorb and retain a liquid, and in some examples, may absorb extremely large amounts of a liquid relative to its mass. Hygroscopic polymers that absorb large amounts of liquids are referred to as superabsorbent polymers. Such water absorbing polymers, which are classified as hydrogels when cross-linked, absorb aqueous solutions through hydrogen bonding with water molecules. A superabsorbent polymer's ability to absorb water generally is a factor of the ionic concentration of the aqueous solution. For instance, in deionized and distilled water, a superabsorbent polymer may absorb 500 times its weight (for example, from 30-60 times its own volume) and can become up to 99.9% liquid, but when put into a 0.9% saline solution, the absorbency drops to approximately 50 times its weight.

[0030] In various embodiments, the total absorbance and swelling capacity may be controlled by the type and degree of cross-linkers used to make the gel. Low density cross-linked superabsorbent polymers generally have a higher absorbent capacity and swell to a larger degree. These types of superabsorbent polymers also have a softer and more sticky gel formation. High cross-link density polymers exhibit lower absorbent capacity and swell, but the gel strength is firmer and can maintain particle shape even under modest pressure.

[0031] Superabsorbent polymers are commonly made from the polymerization of acrylic acid blended with sodium hydroxide in the presence of an initiator to form a poly-acrylic acid sodium salt (e.g., sodium polyacrylate). Other materials also may be used to make a superabsorbent polymer, such as polyacrylamide copolymer, ethylene maleic anhydride copolymer, cross-linked carboxymethylcellulose, polyvinyl alcohol copolymers, cross-linked polyethylene oxide, and starch grafted copolymer of polyacrylonitrile (PAN). In other embodiments, the polymers may be a homopolymer, and may include polysaccharides, polyurethanes, polyamides, polyacrylates.

[0032] In specific embodiments, a highly absorbent polymer element may include, for example, any suitable natural or synthetic polymeric material that, in a dry form, is capable of absorbing and storing many times its weight in water. Specific examples of natural gums that may be used in highly absorbent polymer elements include xanthan, agar, pectin, locust bean gum, hydroxypropyl guar gum, polyglucosmannan gum, cationic guar gum, anionic guar gum, alginate, irish moss, and gum arabic. Specific examples of cellulose derivatives that may be used in highly absorbent polymer elements include methyl cellulose, ethyl cellulose, carboxymethyl cellulose, carboxy ethyl cellulose, hydroxyethyl cellulose, hydroxymethyl cellulose, and hydroxypropylcellulose.

[0033] Specific examples of synthetic hydrogel polymers that may be used in highly absorbent polymer elements include suitable crosslinked, water-swallowable acrylic copolymers. In particular embodiments, the synthetic hydrogel polymers may include copolymers that include repeat units from one or more monomers selected from (meth)acrylic acid, maleic acid, 2-(meth)acrylamido-2-methyl propane sulfonic acid, styrene sulfonate, vinyl sulfonic acid, and their corresponding ammonia, amine and alkali metal salts, (meth)acrylamide, vinyl alcohol, vinyl acetate, maleic anhydride, alkyl vinyl ethers, vinylmorpholinone, vinylpyrrolidone, vinyl pyrrolidone, and acrylonitrile; and one or more crosslinking agents selected from N,N-methylenebis(meth)acrylamide, (poly)ethylene glycol di(meth)acrylate, (poly)propylene glycol di(meth)acrylate, trimethylolpropane tri(meth)acrylate, glycerol tri(meth)acrylate, glycerol acrylate methacrylate, ethylene-oxide-modified trimethylolpropane tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol hexa(meth)acrylate, triallyl cyanurate, triallyl isocyanurate, triallyl phosphate, triallylamine, po-

ly(meth)allyloxyalkanes, (poly)ethylene glycol diglycidyl ether, glycerol diglycidyl ether, ethylene glycol, polyethylene glycol, propylene glycol, glycerol, pentaerythritol, ethylenediamine, ethylene carbonate, propylene carbonate, polyethylenimine, glycidyl (meth)acrylate, diallyl sucrose, triallyl sucrose triallyl amine, and triallyl methyl ammonium chloride. Other specific examples of cooling polymers may include paraffin ($C_nH_{2n}^{2+}$), fatty acids ($CH_3(CH_2)_{2n}COOH$), salt hydrates (M_nH_2O), hygroscopic materials, trimethylolethane, and lauric acid. In particular embodiments, the highly absorbent polymer elements may include polyacrylate and/or sodium polyacrylate mixed or cross-linked with a non-soluble compound, such as polyurethane.

[0034] Other specific examples include styrenic block copolymers, which are thermoplastic elastomers that may include at least three blocks, for instance two hard polystyrene end blocks and one soft, elastomeric (e.g., polybutadiene, polyisoprene, or their hydrogenated equivalents) midblock. In various embodiments, the hard and soft blocks may be immiscible, so that, on a microscopic scale, the polystyrene blocks form separate domains in the rubber matrix, thereby providing physical cross links to the rubber.

[0035] Additional highly absorbent polymers and methods to manufacture such polymers are described in U.S. Patent Nos. 6,469,080, 6,399,668, 6,127,454, 6,087,002, 5,244,735, 4,925,603, and 4,734,478. Additional examples of highly absorbent polymers that may be used in accordance with various embodiments include those available under the trade names ALCOSORB® from Ciba Specialty Chemicals, Chatanooga, Tenn.; DRYTECH® from the Dow Chemical Company, Midland, Mich.; NORSOCRYL® and AQUAKEEP® from Atofina, Paris, France; HYDROSORB™ from HYDROSORB Inc., Orange, Calif.; AQUALIC CA® from Nippon, Shokubai Co., Ltd., Osaka, Japan; and PERMAX™ from The Lubrizol Corporation, Wickliffe, Ohio.

[0036] In various embodiments, the highly absorbent polymer elements **104** may cover a sufficient surface area of the base fabric **102** to achieve the desired degree of cooling, for example, having a surface coverage area of the highly absorbent polymer elements **104** of about 5 - 50%, about 10 - 40%, about 15 - 30%, or about 20% in various embodiments. This coverage range leaves about 50 - 95%, about 60 - 90%, about 70 - 85%, or about 80% of the base fabric **102** uncovered in various embodiments. Generally, a sufficient area of base fabric **102** should be exposed to provide the desired base fabric function (e.g., stretch, drape, texture, breathability, moisture vapor transfer, air permeability, and/or wicking). For example, if there is too little exposed base fabric, properties such as moisture vapor transfer and/or permeability may suffer greatly, and even disproportionately to the percentage of coverage. As used herein, the term "surface coverage area" refers to a measurement taken from seam to seam on a given garment, and does not necessarily correspond to the percentage of the entire garment

covered by the highly absorbent polymer elements.

[0037] In accordance with various embodiments, the base fabric **102** may be a part of any form of clothing or bodywear, which term is used herein to include anything worn on or used close to the body, including athletic wear such as compression garments, t-shirts, shorts, tights, sleeves, headbands outerwear such as jackets, pants, scarves, shirts, hats, gloves, mittens, footwear such as shoes, boots, slippers, sleepwear, such as pajamas, nightgowns, and robes, undergarments such as underwear, thermal underwear, undershirts, brassieres, socks, hosiery and other items used close to the body, such as bedding, towels and backpacks.

[0038] In various embodiments, the highly absorbent polymer elements **104** may be disposed on a base fabric **102** having one or more desired properties or characteristics. For example, the underlying base fabric **102** may have properties such as air permeability, moisture vapor transfer, and/or wickability, which are common needs for bodywear used in both indoor and outdoor applications. In some embodiments, the underlying base fabric **102** may have other desirable attributes, such as abrasion resistance, anti-static properties, anti-microbial activity, water repellence, flame repellence, hydrophilicity, hydrophobicity, wind resistance, UV protection, resiliency, stain resistance, wrinkle resistance. In some embodiments, the areas of uncovered base fabric **102** between and/or inside highly absorbent polymer elements **104** may help allow the base fabric **102** to have a desired drape, look, stretch, and/or texture. Specific examples of suitable base fabrics **102** may include nylon, polyester, rayon, cotton, spandex, wool, silk, or a blend thereof, or any other material having a desired look, feel, weight, thickness, weave, texture, or other desired property. One example for a suitable base fabric **102** is a fabric made from polyester fiber, although any fabric having suitable properties, such as high wickability and very low absorbance may be used. As used herein, the term "low absorbance" when used with reference to a fabric, refers to a fabric having fibers that absorb less than 1.0% moisture by weight when measured at 80% relative humidity and 30°C.

[0039] In various embodiments, configuring the cooling material to allow a designated percentage of the base fabric **102** to remain uncovered by the highly absorbent polymer elements **104** may allow that portion of the base fabric **102** to perform the desired functions, while still leaving enough surface area of highly absorbent polymer elements **104** to cool the body to a desired degree. In various embodiments, single-layer bodywear may be used, and may be comprised of a single layer of the base fabric **102**, whereas other embodiments may use multiple layers of fabric, including, for example, one or more additional layers of the base fabric or another fabric. For instance, the base fabric **102** may be used as a fabric lining for bodywear.

[0040] In various embodiments, the highly absorbent polymer elements **104** may be disposed on a lower or

inside surface of the base fabric **102** (e.g., an inside surface of the body gear, facing the skin), placing the highly absorbent polymer elements **104** in a good position for absorbing sweat directly from the skin of a user. However, in some embodiments, the highly absorbent polymer elements **104** may be at least partially integrated into or may at least partially permeate base fabric **102**, so long as they still face the body of a user.

[0041] In various embodiments, the highly absorbent polymer elements **104** may have little or no endothermicity. Endothermicity is measured using Differential scanning calorimetry (DSC), which is a technique that monitors heat effects associated with phase transitions and chemical reactions as a function of temperature. In a DSC, the difference in heat flow to the sample and a reference at the same temperature is recorded as a function of temperature. The reference is an inert material such as alumina, or just an empty aluminum pan. The temperature of both the sample and reference are increased at a constant rate. Since the DSC is at constant pressure, heat flow is equivalent to enthalpy changes, and can be either positive or negative. In an endothermic process, such as most phase transitions, heat is absorbed and, therefore, heat flow to the sample is higher than that to the reference. Hence $\Delta dH/dt$ is positive.

[0042] In various embodiments, the absorbance of water by certain materials, including certain superabsorbent polymers, is an endothermic process. Prior to the present disclosure, it was believed that the endothermic properties of certain materials, such as cooling polymers and phase change materials, caused the bulk of the cooling sensation perceived by a user of a cooling fabric incorporating these materials. Thus, prior to the present disclosure, polymers deemed suitable for use in cooling fabrics typically had at least some endothermic properties.

[0043] Surprisingly, as disclosed herein, it has now been found that endothermic properties are not necessary or desirable properties for a cooling polymer, as evaporative cooling provides the bulk of the cooling effect that is perceived by a user when the highly absorbent elements are positioned on the body-facing surface of the base fabric. Additionally, endothermic materials can be costly and may have other undesirable characteristics relating to durability and texture. As such, in various embodiments, a highly absorbent polymer for use in the disclosed cooling fabrics may have no endothermic properties. As defined herein, a "non-endothermic" polymer is defined herein to include any polymer having an enthalpy of less than 10 Jg^{-1} as measured by DSC.

[0044] In various embodiments, the highly absorbent polymer elements **104** may be permanently coupled to the base fabric **102** in a variety of ways by gluing, heat pressing, printing, or stitching. In some embodiments, the cooling elements may be coupled to the base fabric by frequency welding, such as by radio or ultrasonic welding. In some embodiments, the highly absorbent polymer elements **104** may be coupled to the base fabric using gravure coating. In some specific examples, the gravure

coating process may use an engraved roller running in a coating bath, which fills the engraved dots or lines of the roller with the coating material (e.g., the gel making up the cooling elements). The excess coating on the roller may be wiped off using a blade, and the coating may then be deposited onto the substrate (e.g., the base fabric) as it passes between the engraved roller and a pressure roller. In various embodiments, the gravure coating process may include direct gravure, reverse gravure, or differential offset gravure, and in various embodiments, the coat weight may be controlled by the percent of solids, the gravure volume, the pattern depth, and/or the speed of the gravure cylinder.

[0045] In various embodiments, the highly absorbent polymer elements may be applied in a pattern or a continuous or discontinuous array. For example, as illustrated in **Figures 2A - 2H**, the highly absorbent polymer elements may take the form of an array of discrete solid or closed loop members, adhered or otherwise secured to the base fabric in a desired pattern. Such a configuration has been found to provide cooling to the user while still allowing the base fabric to perform desired properties (e.g., breathe and stretch). In various embodiments, such discontinuous, discrete, separate cooling elements may take the form of circles, triangles, squares, pentagons, hexagons, octagons, stars, crosses, crescents, ovals, or any other solid shape or a substantially closed loop member that includes a center portion inside the closed loop member wherein the base fabric remains exposed.

[0046] Although the embodiments illustrated in **Figures 2A - 2H** show the highly absorbent polymer elements as separate, discrete elements, in some alternate embodiments, some or all of cooling elements may be arranged such that they are in connection with one another, such as stripes or a matrix/lattice pattern or any other pattern that permits partial coverage of the base fabric. For example, as illustrated in **Figures 3A - 3F**, the configuration of cooling elements disposed on a base fabric may be in the form of a variety of partially or completely, and the pattern may combine both discontinuous elements (such as those illustrated in **Figures 2A - 2H**) and interconnected geometrical patterns (such as those illustrated in **Figures 3A - 3F**). In various embodiments, the pattern of highly absorbent polymer elements may be symmetrical, ordered, random, and/or asymmetrical. Further, as discussed below, the pattern of highly absorbent polymer elements may be disposed on the base fabric at strategic locations to improve the performance of the bodywear. In various embodiments, the size and/or spacing of the highly absorbent polymer elements may also be varied in different areas of the bodywear to balance the need for enhanced cooling properties and preserve the functionality of the base fabric.

[0047] In various embodiments, the placement, pattern, and/or coverage ratio of the cooling elements may vary. For example the cooling elements may be concentrated in certain areas where cooling may be more critical (e.g., the body core) and non-existent or extremely limited

in other areas where the function of the base fabric property is more critical. In various embodiments, different areas of the bodywear may have different coverage ratios, e.g. 30% at the chest and 5% at the limbs, in order to help optimize, for example, the need for cooling and breathability.

[0048] In various embodiments, the size of the highly absorbent polymer elements may be largest (or the spacing between them may be the smallest) in the core regions of the body for enhanced cooling in those areas. and the size of the highly absorbent polymer elements may be the smallest (or the spacing between them may be the largest) in peripheral areas of the body. In some embodiments, the degree of coverage by the highly absorbent polymer elements may vary in a gradual fashion over the entire garment as needed for regional cooling.

Examples

Example 1

[0049] This example illustrates a comparison of the heat-managing properties of an existing cooling polymer fabric (Omni Freeze Zero™) with a new cooling material that has a discontinuous pattern of highly absorbent polymers coupled to a base fabric that has a low resistance to moisture spread. The temperature of both fabrics was measured after having moisture added using a steamer. **Figure 4A** illustrates the Delta T of the control cooling polymer fabric, and **Figure 4B** illustrates the Delta T of the new cooling material. The new cooling material performed better, reaching a larger Delta T while keeping an extended cooling beyond the control cooling polymer fabric.

Claims

1. A cooling material adapted for use with bodywear, comprising: a base fabric having a high wicking rate of greater than 7.6 cm (3 inches) in 10 minutes as defined by a Vertical Wick Test (AATCC 197) and having a performance characteristic; and one or more discontinuous highly absorbent polymer elements which absorb at least 3% moisture by weight at 30°C and 80% humidity, coupled to a body-facing side of the base fabric, wherein the highly absorbent polymer elements have an enthalpy of less than 10 J·g⁻¹ as measured by DSC upon absorbing water or other fluids, wherein the highly absorbent polymer elements are at least two times as absorbent as the base fabric, and wherein the placement and spacing of the one or more highly absorbent polymer elements leaves a portion of the base fabric uncovered by the highly absorbent polymer elements and enables the base material to retain at least partial performance of the performance characteristic.

2. The cooling material of claim 1, wherein the highly absorbent polymer elements are at least ten times as absorbent as the base fabric.

3. The cooling material of claim 1, wherein the highly absorbent polymer elements absorb at least 10% moisture by weight at 30°C and 80% humidity.

4. The cooling material of claim 1, wherein the base fabric absorbs no more than 1 % moisture by weight at 30°C and 80% humidity.

5. The cooling material of claim 1, wherein the base fabric absorbs no more than 0.8% moisture by weight at 30°C and 80% humidity.

6. The cooling material of claim 1, wherein the highly absorbent polymer elements absorb at least 3.3% moisture by weight at 30°C and 80% humidity, and wherein the base fabric absorbs no more than 0.8% moisture by weight at 30°C and 80% humidity.

7. The cooling material of claim 1, wherein a percentage of surface area coverage of the highly absorbent polymer elements is from 5% to 50%.

8. An article of bodywear comprising a cooling material according to any of claims 1 to 7.

9. A method of making a cooling material, comprising: selecting a base fabric having a high wicking rate of greater than 7.6 cm (3 inches) in 10 minutes as defined by a Vertical Wick Test (AATCC 197) and low absorbance of no more than 1 % moisture by weight at 30°C and 80% humidity, and having a performance characteristic; and coupling one or more discontinuous highly absorbent polymer elements which absorb at least 3% moisture by weight at 30°C and 80% humidity to the base material, wherein the highly absorbent polymer elements have an enthalpy of less than 10 J·g⁻¹ as measured by DSC upon absorbing water or other fluids, wherein the highly absorbent polymer elements are at least two times as absorbent as the base fabric, and wherein the placement and spacing of the highly absorbent polymer elements enables the base material to retain partial performance of the performance characteristic.

10. The method of claim 9, wherein the highly absorbent polymer elements are at least four times as absorbent as the base fabric.

11. The method of claim 10, wherein the highly absorbent polymer elements are at least ten times as absorbent as the base fabric.

12. The method of claim 9, wherein the highly absorbent

polymer elements absorb at least 3.3% moisture by weight at 30°C and 80% humidity, and wherein the base fabric absorbs no more than 0.8% moisture by weight at 30°C and 80% humidity.

Patentansprüche

1. Ein zur Verwendung mit Körperbekleidung angepasstes Kühlmaterial, umfassend: ein Grundgewebe mit einer hohen Dochtwirkungsrate von mehr als 7,6 cm (3 Zoll) in 10 Minuten, wie durch einen vertikalen Dochttest (AATCC 197) definiert, und mit einer Leistungscharakteristik; und ein oder mehrere diskontinuierliche, hochabsorbierende Polymerelemente, die bei 30°C und 80% Luftfeuchte mindestens 3 Gew.-% Feuchtigkeit absorbieren, gekoppelt mit einer dem Körper zugewandten Seite des Grundgewebes, wobei die hochabsorbierenden Polymerelemente beim Absorbieren von Wasser oder anderen Flüssigkeiten eine Enthalpie von weniger als $10 \text{ J} \times \text{g}^{-1}$ aufweisen, bestimmt mittels DSC, wobei die hochabsorbierenden Polymerelemente mindestens doppelt so absorbierend sind wie das Grundgewebe und wobei die Platzierung und der Abstand des einen oder der mehreren stark absorbierenden Polymerelemente einen Teil des Grundgewebes durch die hochabsorbierenden Polymerelemente unbedeckt lassen und es dem Grundmaterial ermöglichen, zumindest eine teilweise Leistung der Leistungscharakteristik beizubehalten.
2. Kühlmaterial nach Anspruch 1, wobei die hochabsorbierenden Polymerelemente mindestens zehnmals so absorbierend sind wie das Grundgewebe.
3. Kühlmaterial nach Anspruch 1, wobei die hochabsorbierenden Polymerelemente bei 30°C und 80% Luftfeuchte mindestens 10 Gew.-% Feuchtigkeit absorbieren.
4. Kühlmaterial nach Anspruch 1, wobei das Grundgewebe bei 30°C und 80% Luftfeuchte nicht mehr als 1 Gew.-% Feuchtigkeit absorbiert.
5. Kühlmaterial nach Anspruch 1, wobei das Grundgewebe bei 30°C und 80% Luftfeuchte nicht mehr als 0,8 Gew.-% Feuchtigkeit absorbiert.
6. Kühlmaterial nach Anspruch 1, wobei die hochabsorbierenden Polymerelemente bei 30°C und 80% Luftfeuchte mindestens 3,3 Gew.-% Feuchtigkeit absorbieren und wobei das Grundgewebe bei 30°C und 80% Luftfeuchte nicht mehr als 0,8 Gew.-% Feuchtigkeit absorbiert.
7. Kühlmaterial nach Anspruch 1, wobei ein Prozentsatz der Oberflächenbedeckung der hochabsorbie-

renden Polymerelemente 5% bis 50% beträgt.

8. Körperbekleidung, umfassend ein Kühlmaterial nach einem der Ansprüche 1 bis 7.
9. Verfahren zur Herstellung eines Kühlmaterials, umfassend: Auswählen eines Grundgewebes mit einer hohen Dochtwirkungsrate von mehr als 7,6 cm (3 Zoll) in 10 Minuten, wie durch einen vertikalen Dochttest (AATCC 197) definiert, und einer geringen Absorption von nicht mehr als 1 Gew.-% Feuchtigkeit bei 30°C und 80% Luftfeuchte und mit einer Leistungscharakteristik; und Koppeln eines oder mehrerer diskontinuierlicher, hochabsorbierender Polymerelemente, die bei 30°C und 80% Luftfeuchte mindestens 3 Gew.-% Feuchtigkeit absorbieren, an das Grundmaterial, wobei die hochabsorbierenden Polymerelemente beim Absorbieren von Wasser oder anderen Flüssigkeiten eine Enthalpie von weniger als $10 \text{ J} \times \text{g}^{-1}$ aufweisen, bestimmt mittels DSC, wobei die hochabsorbierenden Polymerelemente mindestens doppelt so absorbierend sind wie das Grundgewebe und wobei die Platzierung und der Abstand der hochabsorbierenden Polymerelemente es dem Grundmaterial ermöglichen, zumindest eine teilweise Leistung der Leistungscharakteristik beizubehalten.
10. Verfahren nach Anspruch 9, wobei die hochabsorbierenden Polymerelemente mindestens vielmals so absorbierend sind wie das Grundgewebe.
11. Verfahren nach Anspruch 10, wobei die hochabsorbierenden Polymerelemente mindestens zehnmals so absorbierend sind wie das Grundgewebe.
12. Verfahren nach Anspruch 9, wobei die hochabsorbierenden Polymerelemente bei 30°C und 80% Luftfeuchte mindestens 3,3 Gew.-% Feuchtigkeit absorbieren und wobei das Grundgewebe bei 30°C und 80% Luftfeuchte nicht mehr als 0,8 Gew.-% Feuchtigkeit absorbiert.

Revendications

1. Matériau rafraîchissant adapté pour être utilisé dans un vêtement porté à même la peau, comprenant :
 - un tissu de base doté d'une vitesse de drainage élevée, de plus de 7,6 cm (3 pouces) en 10 minutes, telle que mesurée dans un essai de mèche verticale (AATCC 197), et offrant une certaine caractéristique de performance,
 - et un élément ou plusieurs éléments distincts, en polymère hautement absorbant, qui absorbe(nt) au moins 3 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante, et atta-

- ché(s) côté corps au tissu de base,
étant entendu
- que les éléments en polymère hautement absorbant présentent, à la suite d'une absorption d'eau ou d'autres liquides, une enthalpie, mesurée par AED (analyse enthalpique différentielle), inférieure à 10 J/g,
 - que les éléments en polymère hautement absorbant sont au moins deux fois plus absorbants que le tissu de base,
 - et que le placement de l'élément ou des éléments en polymère hautement absorbant et leur écartement laissent une partie du tissu de base non recouverte par les éléments en polymère hautement absorbant et permettent au tissu de base de conserver, au moins en partie, sa caractéristique de performance.
2. Matériau rafraîchissant conforme à la revendication 1, dans lequel les éléments en polymère hautement absorbant sont au moins dix fois plus absorbants que le tissu de base.
 3. Matériau rafraîchissant conforme à la revendication 1, dans lequel les éléments en polymère hautement absorbant absorbent au moins 10 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante.
 4. Matériau rafraîchissant conforme à la revendication 1, dans lequel le tissu de base n'absorbe pas plus de 1 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante.
 5. Matériau rafraîchissant conforme à la revendication 1, dans lequel le tissu de base n'absorbe pas plus de 0,8 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante.
 6. Matériau rafraîchissant conforme à la revendication 1, dans lequel les éléments en polymère hautement absorbant absorbent au moins 3,3 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante, et dans lequel le tissu de base n'absorbe pas plus de 0,8 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante.
 7. Matériau rafraîchissant conforme à la revendication 1, dans lequel le pourcentage de surface recouverte par les éléments en polymère hautement absorbant vaut de 5 % à 50 %.
 8. Article d'habillement porté à même la peau, comprenant un matériau rafraîchissant conforme à l'une des revendications 1 à 7.
 9. Procédé de fabrication d'un matériau rafraîchissant, comportant les étapes suivantes :
 - sélectionner un tissu de base doté d'une vitesse de drainage élevée, de plus de 7,6 cm (3 pouces) en 10 minutes, telle que mesurée dans un essai de mèche verticale (AATCC 197), et d'un faible pouvoir d'absorption, ne dépassant pas 1 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante, et offrant une certaine caractéristique de performance,
 - et attacher à ce matériau de base un élément ou plusieurs éléments distincts, en polymère hautement absorbant, qui absorbe(nt) au moins 3 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante, étant entendu
 - que les éléments en polymère hautement absorbant présentent, à la suite d'une absorption d'eau ou d'autres liquides, une enthalpie, mesurée par AED, inférieure à 10 J/g,
 - que les éléments en polymère hautement absorbant sont au moins deux fois plus absorbants que le tissu de base,
 - et que le placement de l'élément ou des éléments en polymère hautement absorbant et leur écartement permettent au tissu de base de conserver, au moins en partie, sa caractéristique de performance.
 10. Procédé conforme à la revendication 9, dans lequel les éléments en polymère hautement absorbant sont au moins quatre fois plus absorbants que le tissu de base.
 11. Procédé conforme à la revendication 10, dans lequel les éléments en polymère hautement absorbant sont au moins dix fois plus absorbants que le tissu de base.
 12. Procédé conforme à la revendication 9, dans lequel les éléments en polymère hautement absorbant absorbent au moins 3,3 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante, et dans lequel le tissu de base n'absorbe pas plus de 0,8 % en poids d'humidité à 30 °C et sous 80 % d'humidité ambiante.

Figure 1A

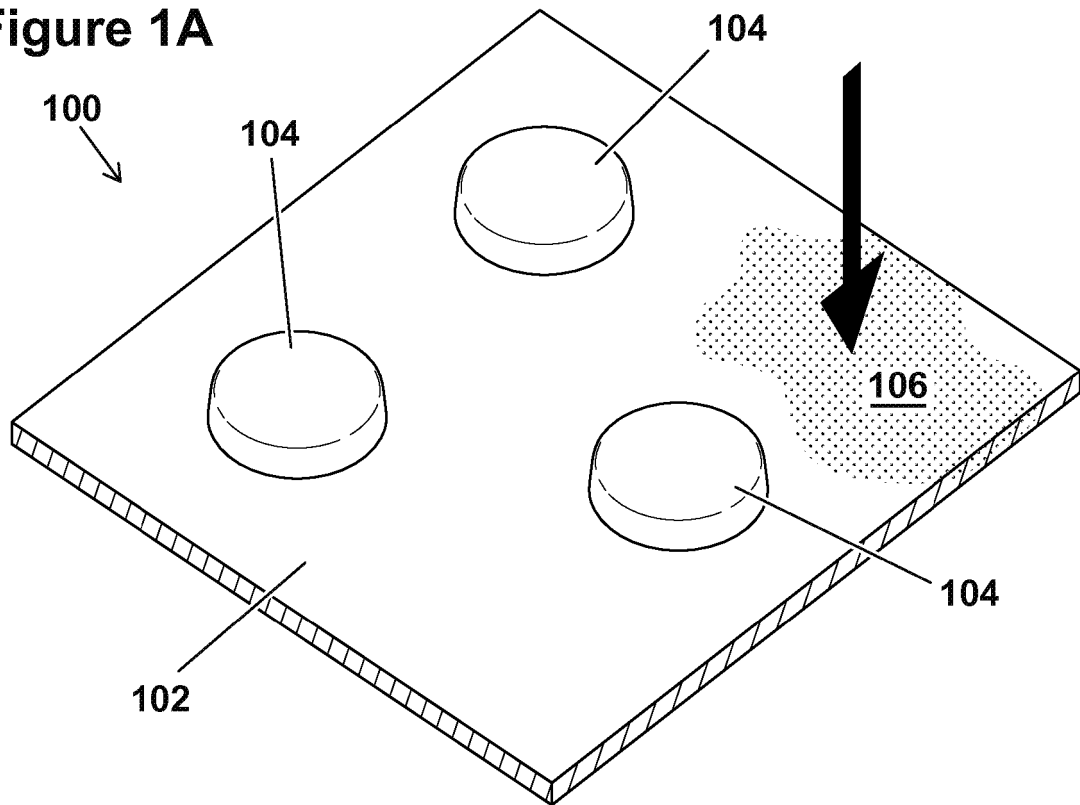


Figure 1B

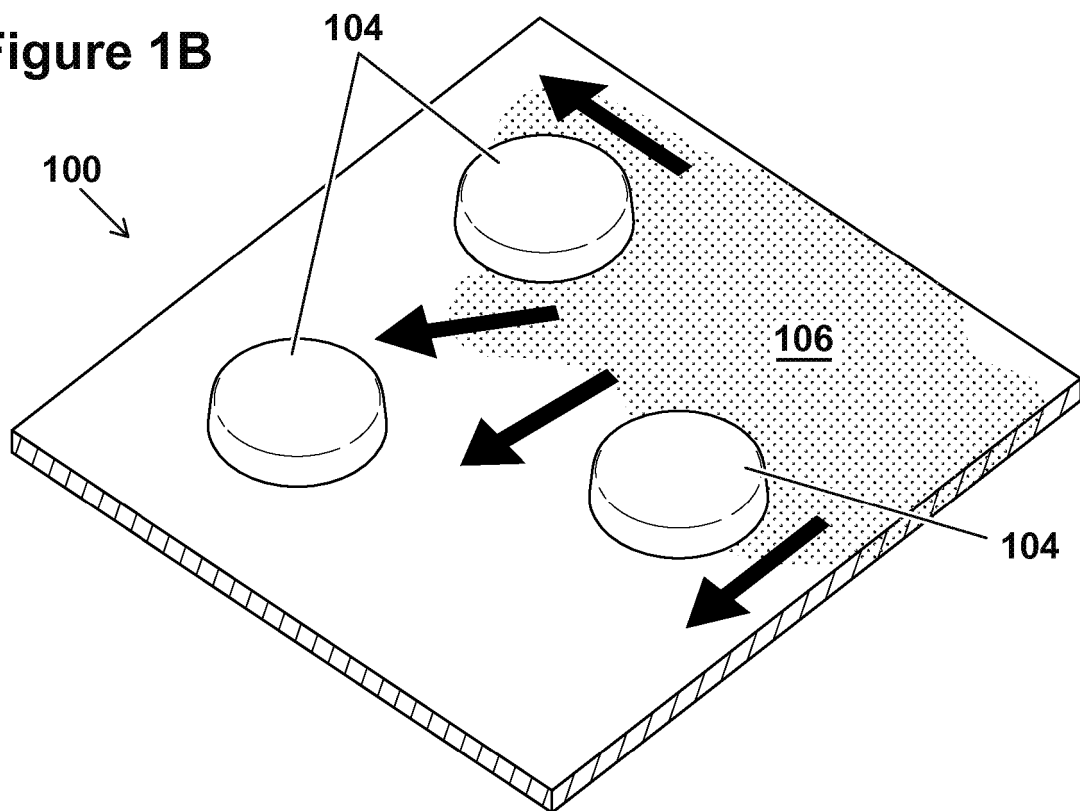


Figure 1C

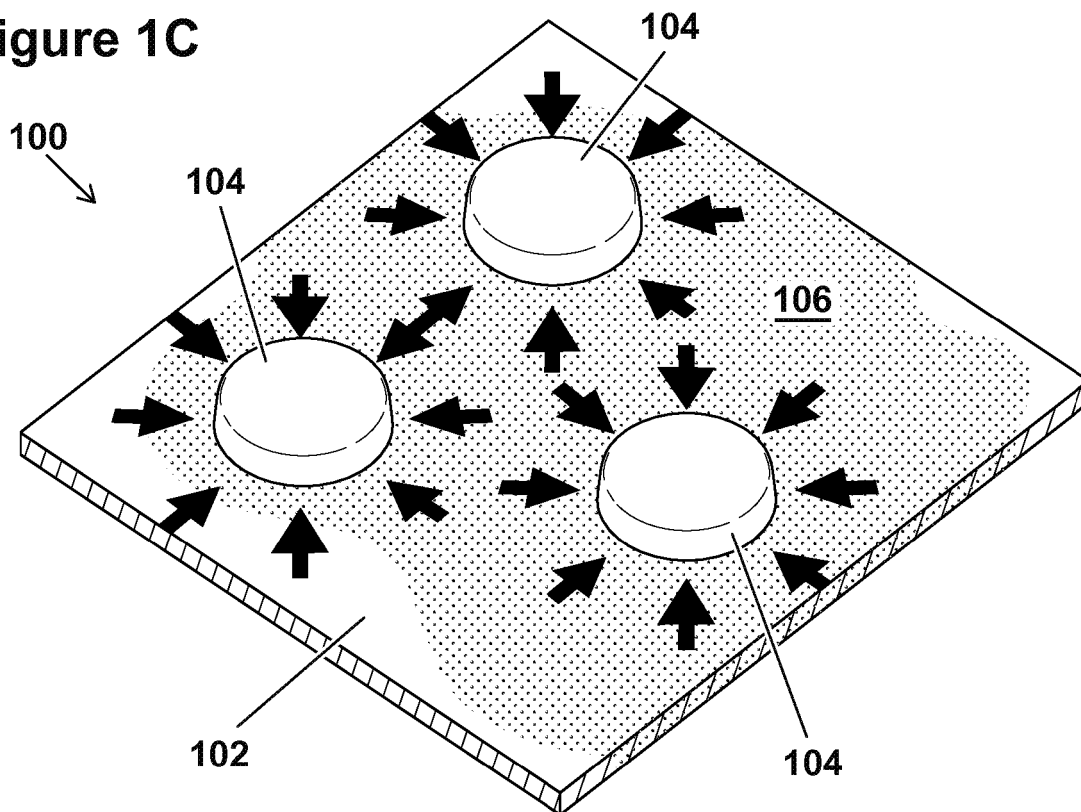
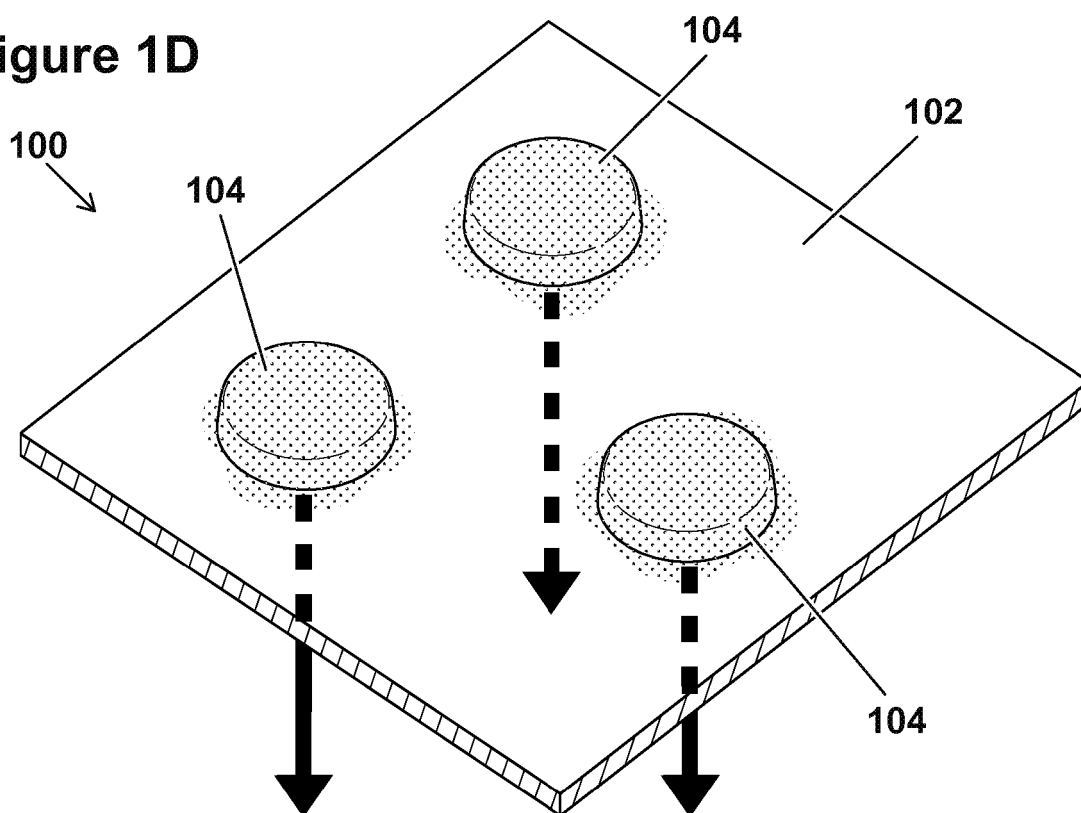


Figure 1D



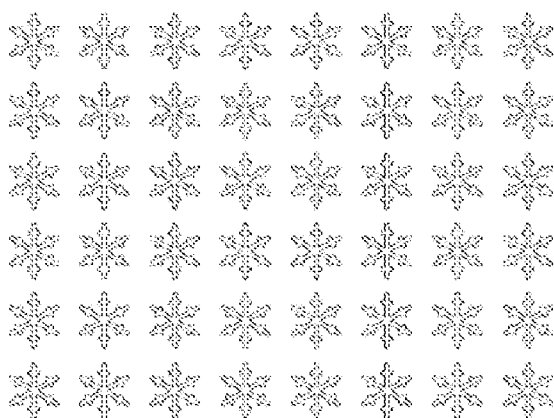


Figure 2A

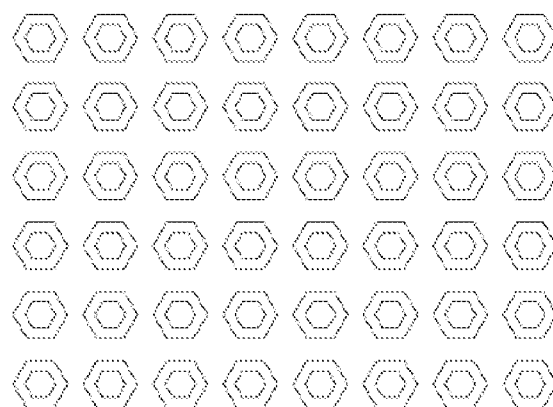


Figure 2B

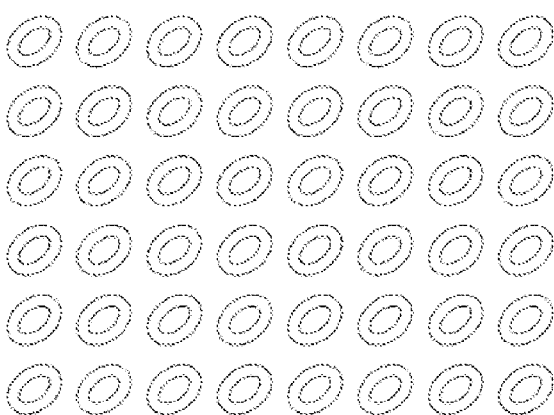


Figure 2C

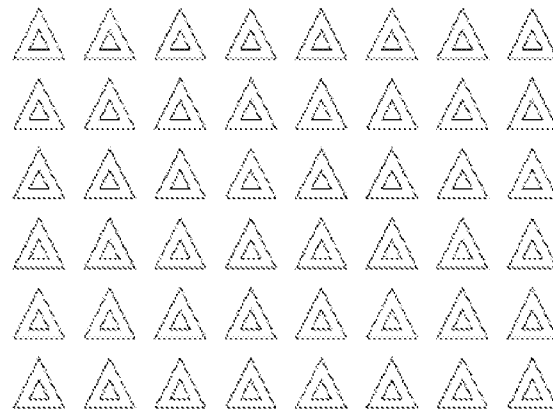


Figure 2D

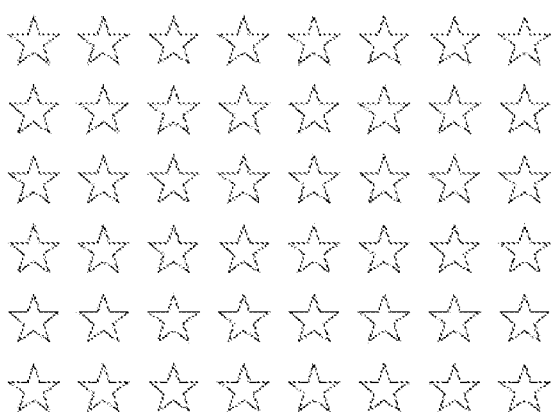


Figure 2E

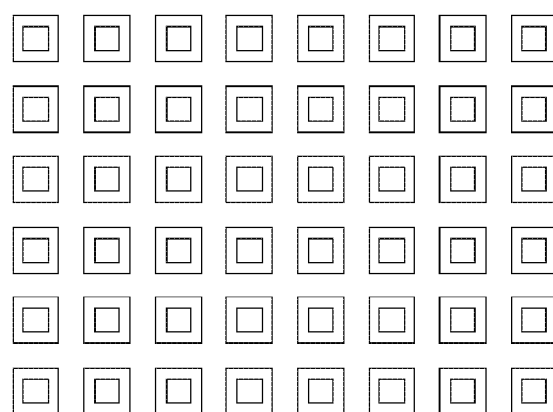


Figure 2F

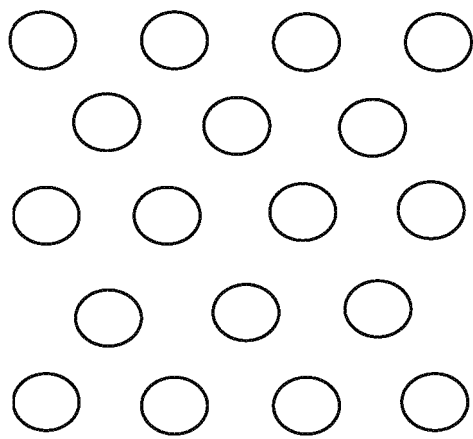


Figure 2G

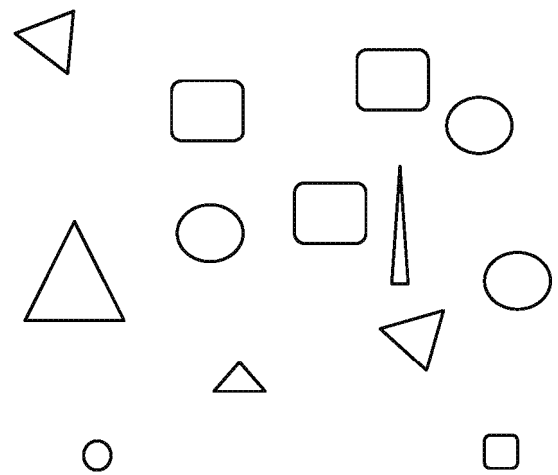


Figure 2H

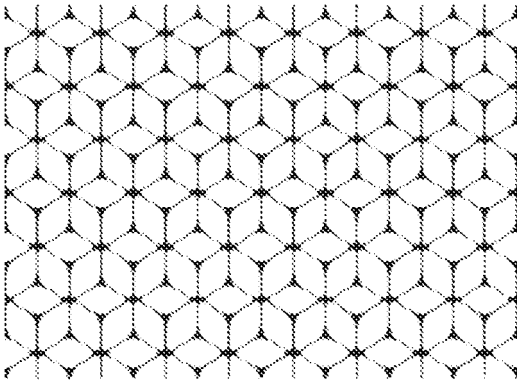


Figure 3A

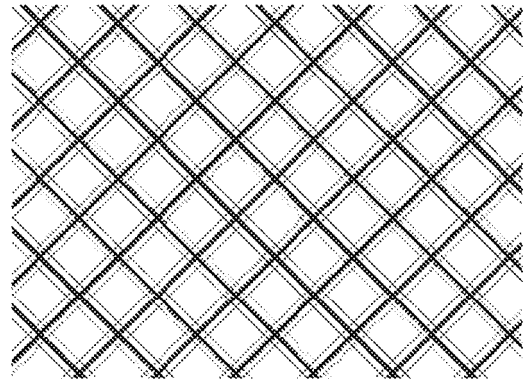


Figure 3B

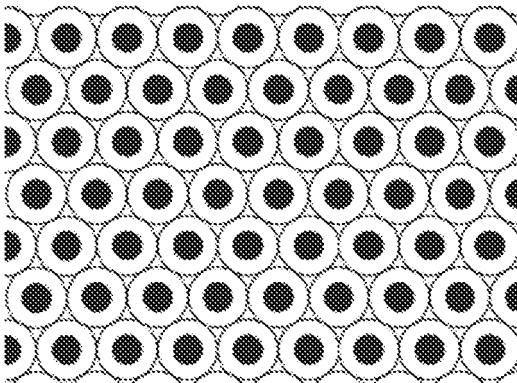


Figure 3C

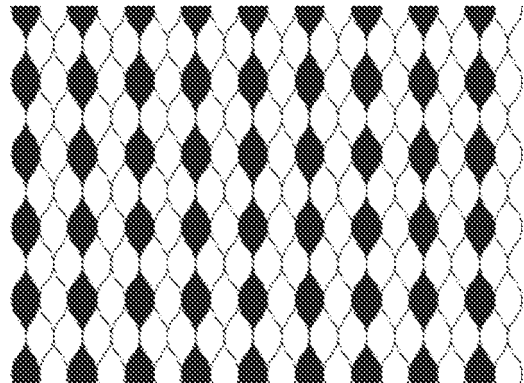


Figure 3D

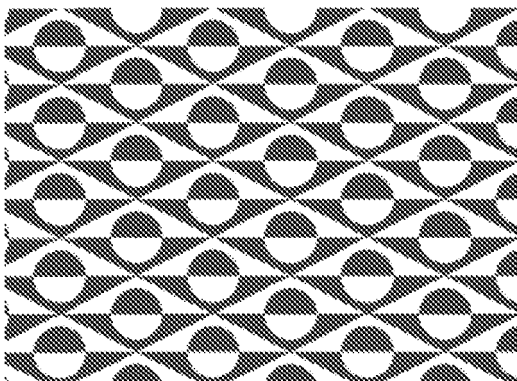


Figure 3E

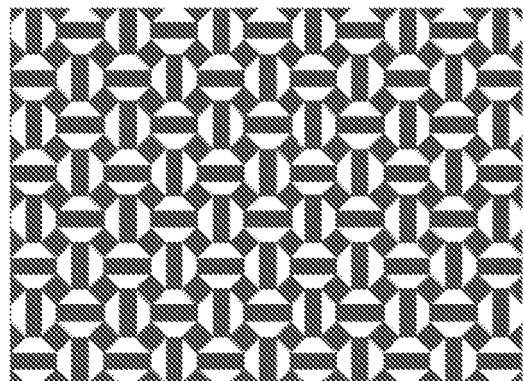


Figure 3F

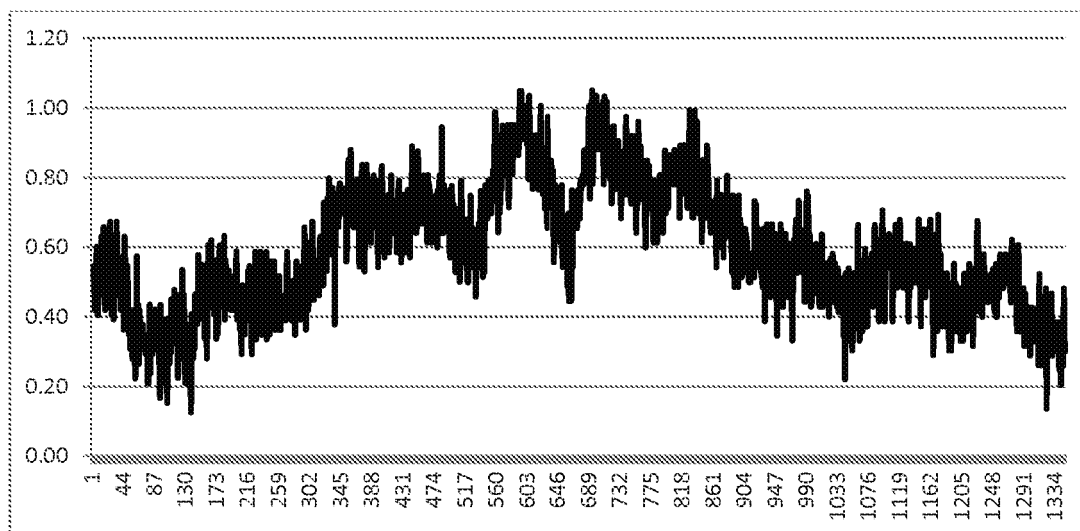


Figure 4A

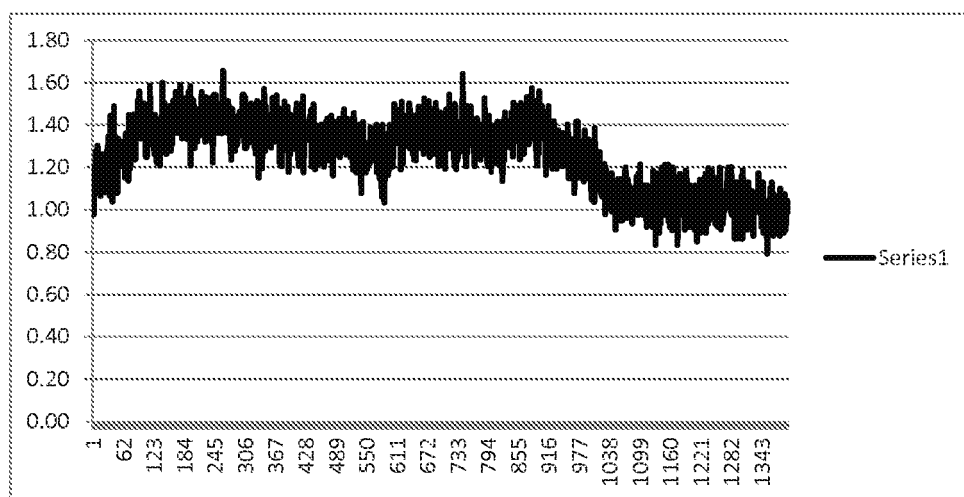


Figure 4B

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1894482 A2 [0003]
- US 20030208831 A1 [0004]
- WO 2013044108 A1 [0005]
- US 6469080 B [0035]
- US 6399668 B [0035]
- US 6127454 A [0035]
- US 6087002 A [0035]
- US 5244735 A [0035]
- US 4925603 A [0035]
- US 4734478 A [0035]