



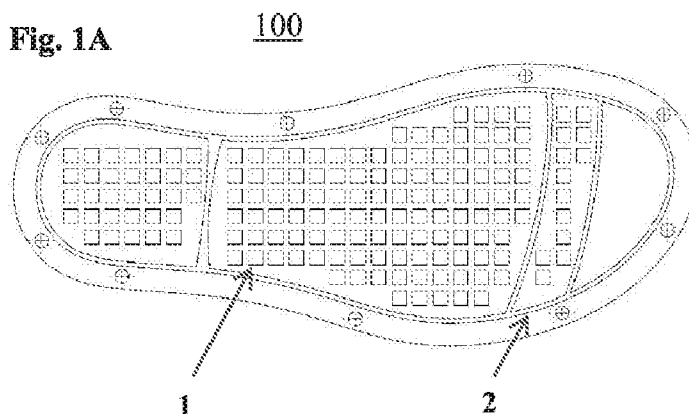
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(54) Title: CUSTOM FORMABLE FOOTBED AND SHOE INSERT



(57) Abstract: A customizable footbed, a self-customizing footwear having a customizable footbed, and a method for customizing a footbed to conform to contours of a foot is provided. The customizable footbed may include a plurality of packets, each packet comprising an exterior membrane defining a chamber therein, and an interior filling within the chamber. The interior filling may be selected from a group consisting of two or more components of a curable material that chemically react upon mixing of the components to irreversibly form a solid or semi-solid resin or a gel. The plurality of packets may be configured to burst upon application of a pressure such that the interior fillings of the packets flow into and mix within the intermediate space.



CUSTOM FORMABLE FOOTBED AND SHOE INSERT

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PRIORITY CLAIM

[0001] This application claims priority to U.S. Provisional Patent Application Serial No.
10 62/295,863 filed February 16, 2016, the entire contents of which is hereby incorporated by
reference herein.

BACKGROUND

[0002] Shoe inserts have long been used to provide better fit, feel and support for the foot
15 within a shoe. Such inserts range from simple linings, to contoured paddings, to support
orthotics. They also range from inexpensive standard insoles, to very expensive custom-fit
inserts. Inexpensive insole options, which often fail to provide sufficient fit and comfort, are
currently produced by one of the following methods: “boil and wear” type solutions, ski-shop
20 spray or heat form solutions. More custom-fit or personalized shoe inserts tend to be very
expensive, and the fitting process sometimes involves a trip to a physician’s office or to a
location with specialized fitting equipment where a scan or mold of the foot can be made. The
customer will often have to wait days or weeks for delivery of the final insert.

[0003] The present invention relates to an improved custom-fit, personalized footbed or
25 insole that is inexpensive and easy to use.

SUMMARY OF THE INVENTION

[0004] In accordance with the foregoing objectives and others, one embodiment of the
present invention provides a customizable footbed. The customizable footbed comprises a top
layer which, when the footbed is in an operating configuration faces a bottom of a foot. The
30 customizable footbed also comprises a bottom layer opposite the top layer which, when the
footbed is the operating configuration is positioned away from the bottom of the foot. The top
and bottom layers defining an intermediate space therebetween. For example, the bottom layer
may comprise an elastomeric polymer. The customizable footbed further comprises a plurality

of packets arranged within the intermediate space. Each packet may comprise an exterior membrane defining a chamber therein, and an interior filling within the chamber. The exterior membrane may comprise a thermoplastic polymer, in particular a low-density polyethylene polymer. The exterior membrane may also have an average thickness from about 5 mm to about 5
10 mm. The interior filling may be selected from a group consisting of two or more components of a curable material that chemically react upon mixing of the components to irreversibly form a solid or semi-solid resin or a gel. The curable material may be a two-component or multi-component resin that spontaneously reacts upon mixing of the components. For example, the curable material may be selected from a group consisting of polyurethane resins, silicone resins,
10 epoxy resins, and melamin resins. In another example, the curable material may be a quick-curing material that solidifies into a desired shape within 30 mins upon mixing of the components. The plurality of packets may be configured to burst upon application of a pressure corresponding to that of the foot being rocked back and forth on the top layer such that the interior fillings of the packets flow into and mix within the intermediate space. For example, the
15 plurality of packets may be configured to burst upon application of a pressure from about 0.1 N/cm² to 1 kN/cm². In some examples, each of the plurality of packets may have a three-dimensional shape. In particular, the three-dimensional shape may be selected from a group consisting of hemis-spherical, cubic, hexagonal prism, pentagonal prism, rectangular prism, square prism, cone, and tetragonal pyramid shapes. More particularly, the each of the plurality
20 of packets may have a square prism shape, in particular, a ratio of a width and a height of the square prism is from about 1:2 to about 2:1, specifically 1:1. In one example, the plurality of packets may be uniformly sized and shaped, and arranged in a two-dimensional array. Furthermore, the packets may be spaced apart by a distance from about 0.05" to about 0.1". In another example, the plurality of packets may be arranged to form at least a first two-
25 dimensional array across a first section of the footbed corresponding to a first portion of the foot, and a second array forming a second section of the footbed corresponding to a second portion of the foot. Furthermore, the plurality of packets may be formed from a singly shaped polymeric film bonded to a flat polymeric film.

[0005] In one aspect, a self-customizing footwear is provided. The self-customizing
30 footwear may comprise an upper, an insole, and an outsole. The insole comprises a top layer which, when the insole is in an operating configuration is faces a bottom of a foot. The insole

also comprises a bottom layer opposite the top layer which, when the insole is the operating configuration is positioned away from the bottom of the foot. The top and bottom layers defining an intermediate space therebetween. The insole further comprises a plurality of packets arranged within the intermediate space, each packet comprising an exterior membrane defining a chamber therein, and an interior filling within the chamber. The interior filling may be selected from a group consisting of two or more components of a curable material that chemically react upon mixing of the components to irreversibly form a solid or semi-solid resin or a gel. The plurality of packets may be configured to burst upon application of a pressure corresponding to that of the foot being rocked back and forth while wearing the footwear such that the interior fillings of the packets flow into and mix within the intermediate space.

[0006] In another aspect, a method for customizing a footbed to conform to contours of a foot is provided. The method may comprise a first step of applying a pressure to burst a plurality of packets. Each packet comprising an exterior membrane defining a chamber therein, and an interior filling within the chamber. The interior filling may be selected from a group consisting of two or more components of a curable material. The method may also comprise a step of mixing the components of the curable material to initiate a chemical reaction such that the components irreversibly react to form a solid or semi-solid resin or a gel. The method may further comprise a step for holding the foot against the footbed for a period of less than 30 mins such that the curable material reacts to form a shape conforming to the contours of the foot.

[0007] In a further aspect, an alternative embodiment for a customizable footbed is provided. The customizable footbed comprises a top layer and a bottom layer. The customizable footbed further comprises a plurality of blister packets arranged between the top and bottom layers. Each packet comprises an exterior membrane defining a chamber therein, and an interior filling within the chamber. The interior filling may be selected from a group consisting of two or more components of a curable material that chemically react upon mixing of the components to irreversibly form a solid or semi-solid resin or a gel. The plurality of blister packets may be configured to rupture upon application of a pressure corresponding to that of the foot being rocked back and forth on the top layer such that the interior fillings of the packets intermix.

[0008] These and other aspects of the invention will become apparent to those skilled in the art after a reading of the following detailed description of the invention, including the figures and appended claims.

BRIEF DESCRIPTION OF THE FIGURES

[0009] Fig. 1A shows a top view of an exemplary embodiment of a portion of a footbed having a plurality of burstable packets containing different components of a curable material that when mixed react to form a solid or semi-solid resin or a gel.

[0010] Fig. 1B shows a prospective view of the exemplary embodiment of a portion of a footbed according to Fig. 1A.

[0011] Fig. 1C shows a side view of the exemplary embodiment of a portion of a footbed according to Fig. 1A.

[0012] Fig. 2A shows a side profile of a portion of an exemplary embodiment of a packet array sheet where the packets have been filled with reactive components for forming a silicone resin prior to sealing within elastomeric top and bottom layers.

[0013] Fig. 2B shows a top view of the exemplary embodiment of a packet array sheet according to Fig. 2A.

[0014] Fig. 3 shows an exemplary embodiment of footbed forming plates of the present invention.

DETAILED DESCRIPTION

[0015] This invention relates to an improved footbed technology that provides a custom-fit, mold-on-demand footbed which molds to the contours of the foot, is pliable, and has the feel of a gel. Please note that in this application, the terms “footbed”, “insole”, and “insert” are used interchangeably. In particular, a customizable footbed comprising an elastomeric bottom layer and a layer of burstable packets coupled to the bottom layer, wherein at least one of the burstable packets have a curable liquid may be provided. The footbeds of the present invention contain a top layer and bottom layer with packets, capsules, blister packets, blisters or bladders (hereinafter referred to as “packets”) arranged in between the two layers, *e.g.*, the top layer and the bottom layer. In one embodiment, the top layer and the bottom layer may define an intermediate space therebetween. A plurality of packets may be arranged in the intermediate space and may each have an exterior membrane defining a chamber therein. The chambers may be filled with an interior filling, which may comprise a component of a two-component or multi-component curable material. The components of the curable material may chemically react, *e.g.*, crosslink,

to form a solid or semi-solid resin or a gel. The exterior membrane of the packets may be formed from a material such that the packets burst during a custom-fit molding process, thereby releasing components of the curable material and allowing the components to be mixed with each other. Packets may take different shapes, sizes, two-dimensional positioning, or wall thickness in order to tune the packet's burst strength. In some applications, it may be important that certain packets burst before others so a mixture of burst strengths may be desired.

[0016] More particularly, the packets may contain components that set or cure upon release from the bursted packets and may combine and react with contents of adjacent packets to initiate curing. Upon mixture of the components, the curable material may begin to cure or set, with or without further reaction or stimuli. In some embodiments, the components of the curable material may spontaneously react with each other upon mixing of the components. In other embodiments, a portion of the packets may contain a catalyst and/or a crosslinking reagent for initiating a chemical reaction, in particular, a cross-linking reaction between different components of the curable material.

[0017] When in use, the footbed with the mixed components may be held against a user's foot such that the curable material cures or sets in a shape that conforms to the contours of the user's foot. The different components released from the packets may flow into each other and pool within the intermediate space, particularly in areas under the foot where voides may exist, *e.g.*, under the arch area, or around the toes. The mixed components may begin to set and cure and solidify after a period of time, preferably a short period of time, such that the curable material surrounds and corresponds to a contour of the foot, *e.g.*, defining a perimeter of the foot and flowing between the toes, arch and metatarsal areas. For example, the curable material may flow under the midfoot or an arch area of the foot, which allows the material to cure and set to provide a cured and lasting impression of the contours of midfoot, arch or the entire foot.

[0018] In one exemplary embodiment, the top and bottom layers are both made of an elastomeric film, and the packets arranged in between the two layers are made from a thermoplastic material. These packets can contain materials that begin to set or cure upon release from the packets and mixing/reacting with contents of adjacent packets. The packets are arranged in arrays and compartments and can be configured to optimize fit upon cure. The packets are arranged in arrays, separated into sections or compartments that correspond to different parts of the foot, *e.g.*, section for toes, section for arch, section for heel (*See* Figs 1A,

1B and 1C). During the custom-fit molding process, the user places the footbed within the shoe, and places his or her foot within the shoe on top of the footbed. The user then presses down on the footbed and rocks the foot back and forth, causing the packets to burst and the packets' contents to mix and react. The mixed material cures to the contours of the foot.

5 [0019] As discussed above, the footbed may comprise a top layer. The top layer may be configured such that in an operating configuration, *i.e.*, when the footbed is being worn by a user in footwear (*e.g.*, inserted into a shoe), the top layer faces a bottom of a foot of the user. The top layer may comprise any suitable material that is wearable against a body part, in particular, that is comfortable against the bottom of the foot, for example, a fabric and/or a polymeric film. In
10 one embodiment, the top layer may comprise a fabric. In another embodiment, the top layer may comprise an elastomeric material, in particular in the form of an elastomeric film. In an alternative embodiment, the top layer may comprise a thermoplastic material, *e.g.*, a thermoplastic polymer. More particularly, the thermoplastic material may comprise a thermoplastic polyurethane (TPU), *e.g.*, a TPU laminate with fabric. The top layer may have
15 any suitable thickness. In some exemplary embodiments, the top layer may have a thickness from about 0.5 mm to about 10 mm, from about 0.5 mm to about 5 mm, or from about 1 mm to about 3 mm.

[0020] The footbed may also comprise a bottom layer, which may be configured such that in an operating configuration, *i.e.*, when the footbed is being worn by a user in footwear (*e.g.*,
20 inserted into a shoe), the bottom layer is opposite the top layer away from the bottom of the foot of the user. The bottom layer may also comprise any suitable material, for example, a polymeric form former, that is comfortable for insertion into footwear (*e.g.*, a shoe). In one embodiment, the bottom layer may comprise an elastomeric material, in particular in the form of an elastomer film. In an alternative embodiment, the bottom layer may comprise a thermoplastic material,
25 *e.g.*, a thermoplastic polymer. More particularly, the thermoplastic material may comprise a thermoplastic polyurethane (TPU) film. The bottom layer may have any suitable thickness. In some exemplary embodiments, the bottom layer may have a thickness from about 1 mm to about 15 mm, from about 3 mm to about 12 mm, from about 5 mm to about 10 mm, or from about 7 mm to about 9 mm.

30 [0021] In one exemplary embodiment, the top layer and/or the bottom layer is preferably made from a breathable, anti-bacterial, anti-fungal and/or anti-odor material. In another

exemplary embodiment, the top layer and/or bottom layer may comprise anti-bacterial, anti-fungal and/or anti-order agent embedded within a polymeric film (e.g., an elastomeric film or a thermoplastic film).

[0022] Figs. 1A, 1B and 1C show an exemplary embodiment of a portion of a footbed 100 having a plurality of burstable packets 1 containing different components of a curable material that when mixed react to form a solid or semi-solid resin or a gel. Each of the packets 1 may comprise an exterior membrane defining a chamber therein for holding an interior filling. The exterior membrane may be formed of any suitable material that are configured to burst upon application of pressure from the user of the footbed, typically by natural motion of hand(s), foot or feet of a user. In particular, the plurality of packets may be configured such that it bursts upon the foot being rocked back and forth on the footbed. By bursting, it is meant that the packets are releasing its interior filling by any suitable means, for example, by rupturing the film structure of the exterior member, or delaminating one or more, seals, adhesives, seams of the exterior membrane that define the chamber therein. Alternatively, the plurality of packets may be configured to burst upon manual application of pressure from the user's hands, such as a pressing or a twisting motion by the hands. The plurality of packets may also be bursted upon bending, crushing, wringing, rolling, folding of the footbed by the hand(s), foot, or feet of the user. The packets may preferably be burstable by hand or foot. In some embodiments, the packets may be burstable with (*i.e.*, have a burst strength of) a pressure ranging from 0.1N/cm² to 1kN/cm²; more preferably the packets may be burstable with (*i.e.*, have a burst strength of) a pressure with burst strength of between 5 and 100 N/cm², and even more preferably the packets may be burstable with (*i.e.*, have a burst strength of) less than 50 N/cm². These metrics can easily be converted to psi. In some embodiments, the plurality of packets within the intermediate space may have different burst strengths. For example, a first component of certain curable materials may need to be released before mixing with a second component of that curable material. Therefore, those packets that contain the first component may have a lower burst strength than those packets that contain the second component, and thereby releasing the first component into the intermediate space before release of the second component to mix with the first component.

[0023] In some embodiments, the interior chamber of the packets may be filled with liquids having high viscosities such that additional mixing by an external source may be necessary. Typically, such additional source for mixing may be applied by hand or by foot or feet of a user

with any type of motion, typically natural motion. For example, such high viscosity fluids may have a viscosity of greater than 1000 cps, greater than 1200 cps, or greater than 1500 cps. The user may burst some or all of the packets by hand prior to putting the insert into the shoe, to aid in mixing, reduce mixing time, or otherwise aid in the custom-molding. For example, the user may apply pressure from the user's hands, such as a pressing or a twisting motion by the hands. The user may also apply additional pressure and mixing by foot, such as by rocking back and forth while standing or pressing against the footbed.

[0024] The exterior membrane of the packets may be formed from any suitable material that can discharge the interior filling therein upon application of the desired pressure, as discussed above. In one particular embodiment, the exterior membrane comprises a thermoplastic polymer, e.g., a thermoplastic film former. More particularly, the thermoplastic material may comprise a thermoplastic polyurethane (TPU) or a low density polyethylene (LDPE), which may be in the form of a polymeric film. The exterior membrane may have any suitable thickness. In some exemplary embodiments, the exterior membrane may have a thickness or an average thickness from about 1 mm to about 20 mm, from about 3 mm to about 18 mm, or from about 5 mm to about 15 mm, or from about 8 mm to about 12 mm. In one particular embodiment, the exterior membrane may have an average thickness from about 5 mm to about 10 mm. The exterior membrane may also be formed from two or more separate sheets of polymer film that are sealed together by any suitable means, including a seal, a weld, an adhesive, etc., which are discussed further below.

[0025] As discussed above, the burstable packets 1 may contain different components of a curable material that when mixed react to form a solid or semi-solid resin or a gel. Generally, the packets may contain solid, liquid or gaseous components (or mixtures thereof or suspensions containing such) that, when mixed, result in some chemical reaction that cures the materials to become a solid in the desired shape and form. In some embodiments, the mixing or reaction may also produce some other effect or attribute such as heat, cold, light, or color change. The color change may aid in identifying whether the bursting and mixing has been performed sufficiently. Each packet may contain one or more of the solid, liquid or gaseous component. In particular, the packets can be filled with a range of two-component or multi-component reactive liquids. For example, each packet may contain one or more of the reactive liquids. Examples of reactive liquids are two-component resins, such as polyurethane resins, silicone resins, epoxy resins,

melamin resins, and polyurea resins; multi-component liquid reactants to affect the production of heat, such as in the dissolution of calcium chloride into water; multi-component liquid reactants to affect the lowering of the temperature, such as the dissolution of ammonium chloride into water; and multi-component liquid reactants to affect the production of light, such as the mixing
5 of luminol and hydrogen peroxide.

[0026] In some exemplary embodiments, the components of the curable material may chemically react, *e.g.*, crosslink, to form a solid or semi-solid resin or a gel. Suitable curable materials may include polyurethane resins, silicone resins, epoxy resins, melamin resins, and polyurea resins. The components may further comprise additional additives that may impart a
10 detectable change upon reaction, *e.g.*, a color change or activating chemiluminescence (*e.g.*, mixing of luminol and hydrogen peroxide). The reaction of the components of the curable material may be either exothermic (*i.e.*, generate heat) or endothermic (*i.e.*, reduces heat). However, the exothermic or endothermic changes of the reaction should be within a tolerable range of temperature changes to the human skin, for example, the exothermic reaction should not
15 release energy that raises the temperature of the footbed to above 90°C, preferably the temperature should be maintained below 75°C, more preferably below 50°C. Similarly, the endothermic changes of the reaction should not reduce the temperature of the footbed to below 0°C, preferably the temperature should be maintained above 10°C, more preferably above 20°C.

[0027] In particular, the components of the curable material may comprise a first component
20 comprising monomers, and a second component comprising crosslinking reagents. Alternatively, the components of the curable materials, *e.g.*, monomers for crosslinking, may be reactive upon exposure to air or components found within ambient air, such as moisture or oxygen. In other embodiments, a portion of the packets may contain a catalyst and/or a crosslinking reagent for initiating a chemical reaction, in particular, a cross-linking reaction
25 between different components of the curable material. In some embodiments, the components of the curable material may spontaneously react with each other upon mixing of the components.

[0028] Suitable two-component curable materials may include a first component (which is also referred to herein after as Component A), and a second component (which is also referred to hereinafter as Component B). In one particular embodiment, the two-component curable
30 material may be a silicone. For example, Component A and Component B may comprise a vinyl-terminated dimethylpolysiloxane and a silicon-hydride crosslinker with platinum catalyst,

respectively. In particular, the two-components may comprise commercially available silicone components: Andisil[®] 204-37C and Andisil[®] 204-37D.

[0029] In a preferred embodiment, the components of the curable material may comprise different reagents for a quick-cure or quick-set curable material. For example, the components
5 of the quick-cure or quick-set curable material may begin to cross-link upon mixing of the components with each other. The quick-cure or quick-set curable material may form a solid or semi-solid resin or a gel in the desired shape, e.g., conforming to contours of a foot, as it crosslinks within about 1 hour of initial mixing, preferably within about 45 mins of initial mixing, more preferably within about 30 mins of initial mixing, and even more preferably within
10 about 20 mins of initial mixing. Even more preferably, the quick-cure or quick-set curable material may solidify or gel within a short period of time, e.g., less than 5 mins, or less than 3 mins.

[0030] The plurality of packets may have any suitable shape. In some embodiments, the packets may be made in different three-dimensional structures, aspect ratios, and overall
15 dimensions, including but not limited to height, width, and wall thickness for different applications. The three-dimensional structure of the packets can be any three-dimensional closed solid comprising flat, contoured and/or curved surfaces; some examples are hemi-spherical, cubic, hexagonal prism, pentagonal prism, square prism, rectangular prism, cone, and tetragonal pyramid shapes. In some embodiments, the plurality of packets may all have a uniform size
20 and/or shape. For example, as shown in Figs. 1A, 1B, and 1C, the packets may each have a square prism shape. In one exemplary embodiment, the packets may have a square prism shape having an aspect ratio (i.e., a ratio of a side of a square to the height of the prism) from about 1:2 to about 2:1. In a preferred embodiment, the aspect ratio of the square prism may be about 1:1. In certain exemplary embodiments, the width of a side of the square prism may range from about
25 0.1" to about 0.5", preferably from about 0.125" to about 0.5".

[0031] Alternatively, the packets may each have a regular or irregular three-dimensional shape and may have any suitable aspect ratio. For an irregular shape, the aspect ratio may be defined as a ratio of an average lateral cross sectional diameter to a height of the shape, which
30 may range from about 1:2 to about 2:1, and preferably about 1:1. The above describe aspect ratios are not limited to irregular shapes, but may be also used for any suitable polygonal three-dimensional shape.

[0032] Furthermore, the plurality of packets may be arranged two-dimensionally on a flat or curved surface. For example, the plurality of packets may be arranged across the bottom layer of the footbed. The curvature of the two-dimensional array may be optimized to maximize the ease of packet bursting by the user. The spacing, distribution, shape, and size of the packets can also be varied to maximize the ease of bursting by the user. The spacing between the packets may vary between a nil thickness and 100 centimeters. More particularly, the spacing between packets may range from about 0.01" to about 0.5", from about 0.03" to about 0.3", or from about 0.05" to about 0.1". Packets may be all the same size and shape or comprise a variety of different shapes within the same footbed. In one embodiment, the packets may be arranged to form a two-dimensional array along the length and width of the footbed. Such an arrangement may be useful for optimizing fit against an entire contour of the foot upon mixing and curing of the components of the curable material.

[0033] The most preferable arrangement of packets is a pattern of identical shaped and sized close-packed polygonal prisms, such as cubes, rectangular prisms, or hexagonal prisms. This arrangement allows the air to be evacuated efficiently from the outside thermoplastic, elastomeric bag. In this arrangement, a two-component resin can be distributed in packets such that parts A and B (*i.e.*, the parts to be mixed) are spaced out in separate packets in an alternating fashion. Such an alternating arrangement may further allow for thorough mixing of components A and B upon bursting of the packets.

[0034] As shown in Figs. 1A, 1B, and 1C, the plurality of packets may be arranged into a two-dimensional array. For example, the plurality of packets may have a square prism shape and arranged into an array that resembles a grid. Each packet, which has a square prism shape, may be spaced a predetermined distance from an adjacent packet. More particularly, the spacing between packets may range from about 0.01" to about 0.5", from about 0.03" to about 0.3", or from about 0.05" to about 0.1". In some embodiments, the packets may contain two different interior fillers: a first interior filler containing a first component of a two component curable material (which is also referred to herein after as Component A), and a second interior filler containing a second component of a two component curable material (which is also referred to hereinafter as Component B). Each of the plurality of packets in the grid may be filled in an alternating such that no packet contains the same type of filler as an adjacent packet, as shown for example below:

A	B	A	B	A	B
B	A	B	A	B	A
A	B	A	B	A	B
B	A	B	A	B	A
A	B	A	B	A	B

[0035] In some embodiments, the plurality of packets may be arranged to form multiple arrays arranged across different sections of the foot. In one embodiment, the plurality of packets may be arranged to form at least a first two-dimensional array across a first section of the footbed corresponding to a first portion of the foot, and second array forming a second section of the footbed corresponding to a second portion of the foot. In one exemplary embodiment, each section is sealed from the next section such that no fluid communicates between the different sections. In some embodiments, each section may be compartmentalized to control the flow of the components of the curable material to different areas of the foot. For example, an area of the footbed corresponding to the toes may comprise one compartment/section of burstable packets, an area of the footbed corresponding to an arch area of the foot may comprise another compartment/section of burstable packets, and an area of the footbed corresponding to a heel portion of the foot may also comprise a further compartment/section of burstable packets to direct curable material to desired locations to allow for improved shaping of the footbed to provide proper foot support in these desired regions.

[0036] Each section may also include packets that are sized and shaped suitable for that particular section, for example, a first section may comprise an array having a first set of uniformly sized and shaped packets that are different from a second set of uniformly sized and shaped packets that are part of a second section. Although two different sections are discussed above, it is understood that more than two sections and therefore, more than two two-dimensional arrays may be utilized in the footbed of the present invention.

[0037] As can be seen in Figs. 1A, 1B and 1C, the footbed may be separated into compartments or regions such as a toe region 2, an arch region 3, and a heel region 4. In addition, these figures show a border surrounding the footbed area which allows the footbed to be clamped during manufacturing processes.

[0038] In one exemplary embodiment, the plurality of packets may be formed by bonding together two plastic sheets, preferably two polymeric films, more particularly two thermoplastic films. The two plastic sheets that bond together to form the packet may both be thermoformed, blow molded, or otherwise shaped to define the packet volume or only one sheet can be shaped.

5 The preferred embodiment for the moldable footbeds is a singly shaped low-density polyethylene sheet bonded to a flat low-density polyethylene sheet. In the preferred embodiment for the moldable footbed, the polyethylene is thermally welded to the adjacent sheet to define the seams of each packet.

[0039] Packets may be formed from any materials that can be sealed to each other by some
10 means. Methods of sealing the packet seams include thermally welding, sonically welding, mechanically folded together, using a curable adhesive, or using a hot-melt adhesive or thermoplastic). For other applications, the packets could be formed by thermal or sonic welding of thermoplastic sheets or it may be desirable to use an adhesive or other material to form a significantly stronger or weaker bond to tune the delamination of the packet seam. For example,
15 all inner seams of the individual packets in the array may be tuned to delaminate while the outer seams remain laminated such that the packet array becomes one continuous pouch after bursting. The shaped plastic sheet could also form packets with hard non-porous surfaces, such as glass, metal, rock, or a coated surface.

[0040] In a preferred method of making the footbed of the present invention, the packet
20 arrays are formed by vacuum forming thermoplastic sheets into bubble sheets. The thermoplastic material can survive strenuous conditions during manufacturing, shipment and handling but bursts when body weight pressure is applied. This prevents premature curing and preserves on-demand molding functionality. The arrayed packets are filled with resin and a backing layer is thermally sealed to the open back of the packets to form an arrayed sheet of packets, which can
25 be seen in Figure 2. The arrayed packet spacing and individual packet volume can be optimized in order to achieve the desired resin volume. When multiple components are desired, packet characteristics can be customized in order to contain the required volume. Also, an arrayed packet design allows for quick mixing by holding components in close proximity to each other. Upon bursting, each packet of material can be in close proximity to other packets. The preferred
30 embodiment has an array of packets optimized for the desired volume and with curing components in close proximity.

[0041] In another embodiment, the footbed of the present invention may be enclosed in a compartment within the shoe. The footbed may be enclosed in a way that it may be slid in and out, removed and replaced, or permanently enclosed.

[0042] The footbed may be included in an item of self-customizing footwear. The item of self-customizing footwear may comprising an upper, an insole, and an outsole, wherein the insole comprises an elastomeric upper layer positioned to contact with the bottom of the foot; an elastomeric bottom layer coupled to the outsole; and a middle layer enclosed between the upper layer and lower layer; and the middle layer comprising a plurality of burstable packets having a curable liquid material. Additionally, at least some of the burstable packets are configured to burst under pressure from a foot subject to a weight bearing action, and wherein upon bursting, the curable liquid material flows within the enclosed middle layer to conform to and solidify in the shape of the foot. The middle layer may also be divided into a plurality of compartments, wherein the quantity and/or composition of curable liquid material differs between each of the compartments. Furthermore, the compartments may be configured to control flow of material and compensate for different pressure applied by different portions of the foot during the weight bearing action.

EXAMPLES

Example 1

[0043] The steps for producing footbeds of a preferred embodiment of the present invention are as follows: First, materials are prepared by cutting LDPE, TPU, fabric, and transfer adhesive to the proper size required. With the LDPE sheeting, custom bubble arrays are formed by vacuum thermoforming of the film. The LDPE sheeting is brought into close proximity of a high temperature heat source, kept at 275°C. Once the material begins to soften and exhibits characteristics of melting, the sheeting is then brought into contact with a custom mold that is arranged on a vacuum plate, allowing the softened material to form a net shape of the custom mold. Once this custom bubble arrangement is formed, the piece is then placed into a custom holder with rigid channels between the formed bubbles, allowing the bubbles to hang freely. In this holder, silicone components are then loaded into the bubbles in an alternating fashion. Once the bubbles are filled, a sheet of LDPE is then laid across the loaded bubbles. Using a high temperature and high pressure pneumatic thermal press, this film is pressed into the custom

bubble arrays, forcing a high pressure gradient where the rigid channel below lies, allowing the LDPE to seal to itself through the silicone contamination. This completes the formation of the silicone loaded bubble arrays.

5 [0044] Using the prepared TPU sheeting, two films are placed directly on top of one another and a desired fabric top cover is applied to the top surface using a double sided transfer tape adhesive. With the fabric in place, the silicone loaded bubble array is aligned in proper position in between the two TPU sheets. With this array in place, three sides of the film stack are heat sealed, creating TPU-TPU bonds around the outer edge. With these seals completed, the final open side is then used to evacuate the excess air held within the films, creating a vacuum tight seal of the TPU sheeting around the custom bubble arrays. Once the air has been evacuated, the 10 TPU sheets are then heat sealed using a custom sealing plate kept at high temperature and pressure, forming the overall shape of an insole complete with sealed partitions in specific areas of the insole to separate bubbles in certain regions of the foot. Once this seal has been created, the net shape desired for further manufacturing is then cut and the custom moldable layer of the 15 insole is completed.

[0045] The materials used for the production of the insoles, including the commercial suppliers' information, are as follows:

- a. Silicone filler material is Andisil 204-37 Parts C&D, supplied by AB Specialty Silicones
- b. Bubble films formed from LDPE, 10mil film thickness, supplied by SC Johnson. Film 20 with no slip additive preferred.
- c. TPU sheeting is product DT-7101, 8 mil film thickness, supplied by American Polyfilms Inc.
- d. Fabrics provided by Cosmo Fabrics

25 *Example II*

[0046] In another embodiment, the packets may be formed in a square prism blisters having the following aspect dimensions. .25" x .25" x .25" (1:1 aspect ratio). The packets may contain two different interior fillers (A and B) arranged in an alternating fashion. Each packet may be spaced apart from an adjacent packet by a gap between 0.05"-0.1".

30 [0047] The materials used for the production of the insoles, including the commercial suppliers' information, are as follows:

[0048] Interior filling / silicone:

- Andisil® 204-37C having a viscosity- 1950 cps
- Andisil® 204-37D having a viscosity- 1450 cps
- 1:1 mixed gel time (20 sec mix)- 55 sec
- 5 • Properties - cure 20 minutes at RT:

[0049] Bottom TPU Layer: Product: DT 7101, polyether TPU film

[0050] Top Fabric Specs:

- Product: Jump Spacer + 2mil TPU Laminate + Print
- Company: Cosmo Fabrics

10 [0051] Packet exterior membrane: LDPE

[0052] The invention described and claimed herein is not to be limited in scope by the specific embodiments herein disclosed since these embodiments are intended as illustrations of several aspects of this invention. Any equivalent embodiments are intended to be within the scope of this invention. Indeed, various modifications of the invention in addition to those shown and described herein will become apparent to those skilled in the art from the foregoing description. Such modifications are also intended to fall within the scope of the appended claims. All publications cited herein are incorporated by reference in their entirety.

15

CLAIMS

What is claimed is:

- 5 1. A customizable footbed comprising:
a top layer which, when the footbed is in an operating configuration faces a bottom of a
foot;
a bottom layer opposite the top layer which, when the footbed is the operating
configuration is positioned away from the bottom of the foot, the top and bottom layers defining
10 an intermediate space therebetween; and
a plurality of packets arranged within the intermediate space, each packet comprising an
exterior membrane defining a chamber therein, and an interior filling within the chamber, the
interior filling being selected from a group consisting of two or more components of a curable
material that chemically react upon mixing of the components to irreversibly form a solid or
15 semi-solid resin or a gel,
wherein the plurality of packets are configured to burst upon application of a pressure
corresponding to that of the foot being rocked back and forth on the top layer such that the
interior fillings of the packets flow into and mix within the intermediate space.
- 20 2. The customizable footbed of claim 1, wherein the bottom layer comprises an elastomeric
polymer.
3. The customizable footbed of claim 1, wherein the exterior membrane comprises a
thermoplastic polymer.
- 25 4. The customizable footbed of claim 3, wherein the exterior membrane comprises a low-
density polyethylene polymer.
5. The customizable footbed of claim 3, wherein the exterior membrane has an average
30 thickness from about 5 mm to about 10 mm.

6. The customizable footbed of claim 1, wherein the curable material is a two-component or multi-component resin that spontaneously reacts upon mixing of the components.
7. The customizable footbed of claim 6, wherein the curable material is selected from a group consisting of polyurethane resins, silicone resins, epoxy resins, and melamin resins.
8. The customizable footbed of claim 1, wherein the curable material is a quick-curing material that solidifies into a desired shape within 30 mins upon mixing of the components.
9. The customizable footbed of claim 1, wherein the plurality of packets are configured to burst upon application of a pressure from about 0.1 N/cm² to 1 kN/cm².
10. The customizable footbed of claim 1, wherein each of the plurality of packets has a three-dimensional shape.
11. The customizable footbed of claim 1, wherein the three-dimensional shape is selected from a group consisting of hemis-spherical, cubic, hexagonal prism, pentagonal prism, rectangular prism, square prism, cone, and tetragonal pyramid shapes.
12. The customizable footbed of claim 11, wherein each of the plurality of packets has a square prism shape
13. The customizable footbed of claim 12, wherein a ratio of a width and a height of the square prism is from about 1:2 to about 2:1.
14. The customizable footbed of claim 13, wherein a ratio of a width and a height of the the square prism is 1:1.
15. The customizable footbed of claim 1, wherein the plurality of packets are uniformly sized and shaped, and arranged in a two-dimensional array.

16. The customizable footbed of claim 15, wherein the packets are spaced apart by a distance from about 0.05" to about 0.1".

5 17. The customizable footbed of claim 1, wherein the plurality of packets are arranged to form at least a first two-dimensional array across a first section of the footbed corresponding to a first portion of the foot, and a second array forming a second section of the footbed corresponding to a second portion of the foot.

10 18. The customizable footbed of claim 1, wherein the plurality of packets are formed from a singly shaped polymeric film bonded to a flat polymeric film.

19. A self-customizing footwear comprising:
an upper,
an insole, and
15 an outsole,
wherein the insole comprises
a top layer which, when the insole is in an operating configuration is faces a bottom of a foot;
a bottom layer opposite the top layer which, when the insole is the operating
20 configuration is positioned away from the bottom of the foot, the top and bottom layers defining an intermediate space therebetween; and
a plurality of packets arranged within the intermediate space, each packet comprising an exterior membrane defining a chamber therein, and an interior filling within the chamber, the interior filling being selected from a group consisting of two or
25 more components of a curable material that chemically react upon mixing of the components to irreversibly form a solid or semi-solid resin or a gel,
wherein the plurality of packets are configured to burst upon application of a pressure corresponding to that of the foot being rocked back and forth while wearing the
30 footwear such that the interior fillings of the packets flow into and mix within the intermediate space.

20. A method for customizing a footbed to conform to contours of a foot, comprising:
applying a pressure to burst a plurality of packets, each packet comprising an exterior membrane defining a chamber therein, and an interior filling within the chamber, the interior filling being selected from a group consisting of two or more components of a curable material;
5 mixing the components of the curable material to initiate a chemical reaction such that the components irreversibly react to form a solid or semi-solid resin or a gel; and
holding the foot against the footbed for a period of less than 30 mins such that the curable material reacts to form a shape conforming to the contours of the foot.
- 10 21. A customizable footbed comprising:
a top layer;
a bottom layer; and
a plurality of blister packets arranged between the top and bottom layers, each packet comprising an exterior membrane defining a chamber therein, and an interior filling within the
15 chamber, the interior filling being selected from a group consisting of two or more components of a curable material that chemically react upon mixing of the components to irreversibly form a solid or semi-solid resin or a gel,
wherein the plurality of blister packets are configured to rupture upon application of a pressure corresponding to that of the foot being rocked back and forth on the top layer such that
20 the interior fillings of the packets intermix.

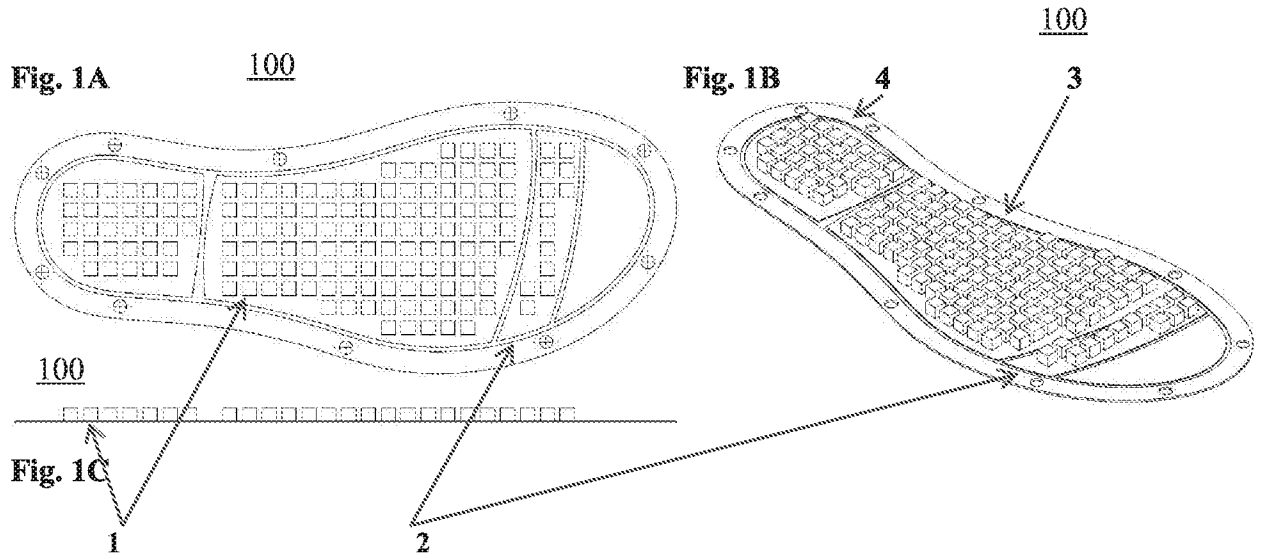


Fig. 2A

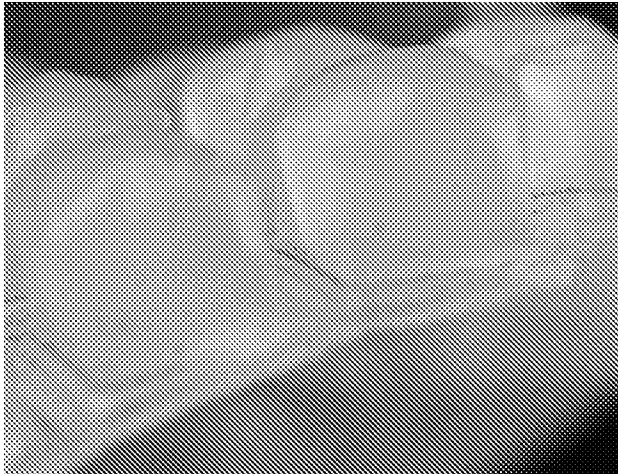


Fig. 2B

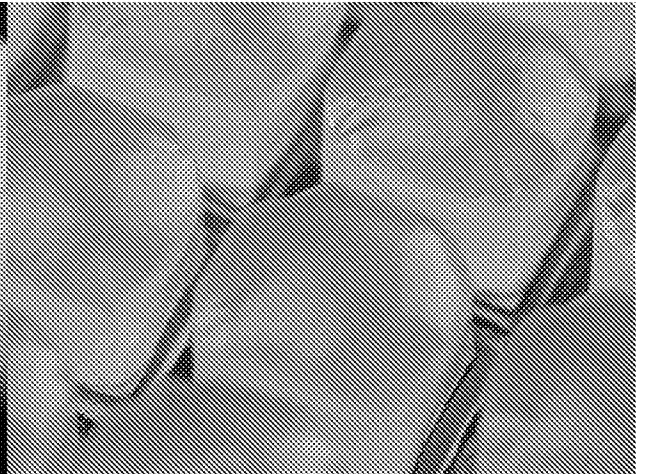
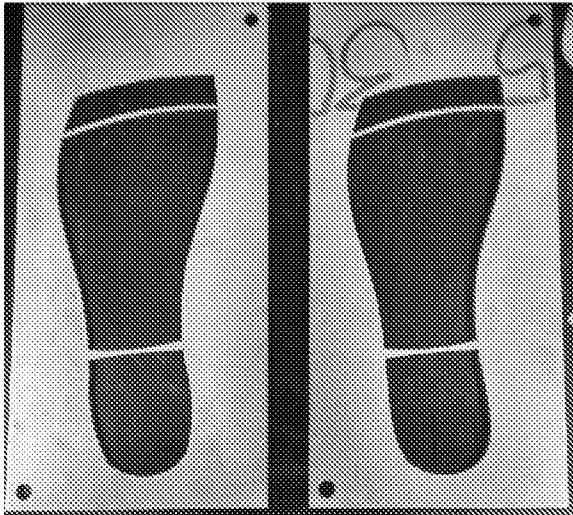


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/018198

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A43B 7/28; A43B 17/14; A61F 5/14 (2017.01)

CPC - A43B 7/28; A43B 7/226; A43B 17/14; A61F 5/14 (2017.02)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

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

USPC - 12/146M; 12/142N; 36/44; 36/93; 36/154 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010/130283 A1 (M.G.S. S.R.L. et al) 18 November 2010 (18.11.2010) entire document	1-7, 9-19, 21
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Y		8, 20
Y	US 5,555,584 A (MOORE, III et al) 17 September 1996 (17.09.1996) entire document	8, 20
A	US 6,098,315 A (HOFFMANN, III) 08 August 2000 (08.08.2000) entire document	1-21
A	US 6,971,193 B1 (POTTER et al) 06 December 2005 (06.12.2005) entire document	1-21
A	US 4,385,024 A (TANSILL) 24 May 1983 (24.05.1983) entire document	1-21

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

10 April 2017

Date of mailing of the international search report

08 MAY 2017

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