

DYNAMIC PRESSURE OFFLOADING INSOLES

DISCLAIMER

5 [0001] Portions of this patent document may contain material that may be subject to copyright OR Trademark protection. The owner has no objection to the facsimile reproduction by anyone of the patent document or the patent disclosure, as it appears in the Patent and Trademark Office file or records, but otherwise reserves all copyright rights and trademarks whatsoever. All copyrights and trademarks are owned by Indian Institute of Science, Bangalore.

10 TECHNICAL FIELD

[0002] This disclosure relates generally to insoles for footwear that provide support to the foot by way of nodules that have a spring like action to dynamically offload the pressure from the foot and the insole may be used in any type of footwear.

BACKGROUND

15 [0003] Footwear forms a very important part of a human's life. The human foot is an incredible biological machine and is strong enough to support repeated impacts of running and the constant pressure of standing. The human foot is designed to manage disparate tasks by a collection of bones and muscles. Only when these bones and muscles are functioning in a proper manner, can the foot fully perform its intended functions. These bones and muscles
20 must be maintained at the optimal positions for the foot to function properly.

[0004] For example, footwear which is not properly designed to support the foot, especially the in-sole may in fact lead to causing temporary or permanent injuries to the foot and/or the leg, which may translate to other forms of injuries to the human body. In another example, in case of humans with a history of diabetes, peripheral neuropathy may be considered as one of
25 the four major long-term complications, leading to severe complication to the foot. Humans with varying blood sugar in general tend to have ill-monitored feet leading to foot ulcers because of the formation of high-pressure points on the sole of the foot, which may lead to other complications and if not taken care of, such as gangrene, and eventually lead to amputation of the foot.

30 [0005] One way to treat foot ulcers and high-pressure points that occur in the sole of the foot is to cut out a pocket from the sole of the footwear by identifying the area of an ulcer site or contour the footwear to reduce pressure from the plantar surface of the foot sole. This process is typically referred to as static offloading, where high-risk areas may be identified by using a

plantar pressure distribution system in the standing position for a human, and then those portions may be appropriated contoured on the footwear.

[0006] However, the plantar pressure is not static and varies dynamically while the human person is walking and/or moving their feet. The plantar pressure can also vary from person to person due to a number of factors, such as weight of the person, walking style of the person etc. Therefore, identifying the plantar pressure points and statically offloading the pressure by cutting of part of the footwear or contouring the footwear may not be an effective solution as it accounts only for the standing condition of a human foot and not for dynamically changing position of the human foot. A further disadvantage associated with such a static offloading is that these high-pressure points on the plantar surface (sole of the foot) may keep changing over time or increasing in size over time, which may necessitate frequent changing of footwear, and cutting out pockets or contouring the footwear such that these newly developed high-pressure points may be taken care off.

[0007] Footwear, for example shoes, may be designed and assembled to accommodate such pressure points, but currently available footwear often fails to provide the required support and stimulation desired for the foot at the position of these pressure points. Further, current footwear is not designed to dynamically offload pressure from high pressure points, for example, if a human experiences high-pressure at the heel due to long standing, current footwear is not designed to dynamically offload such high-pressure points. Thus, what is needed is an insole which may be designed to support the foot properly and also take care of dynamically offloading the changing and varying pressure applied on the sole of the foot.

SUMMARY

[0008] Embodiments of the present disclosure relate to a nodule (also referred to as a nodule structure or snapping support arch structure or retorting arch structure) and footwear inner sole comprising a plurality of nodules that may be three-dimensionally printed or molded and affixed onto a base forming the inner sole. In an embodiment, the nodules may be formed by printing in three-dimension using a three-dimensional printer or created by a mold. In an embodiment, the nodules may be formed individually or in a group. In an embodiment, the nodules may be formed in a particular shape, for example square, circle etc. In a further embodiment, the nodules may be formed in dimension or sizes, for example varying in length and width along a two-dimensional place, for example the XY plane along a 3-dimensional plane. In an embodiment, the nodules may be formed with varying heights along an axis of the three-dimensional plane, for example the Z-axis. In an alternatively embodiment, the

nodules may be formed in different shapes and sizes as required in a customized form.

[0009] In an embodiment, the nodules once prepared or formed, either by 3D printing or molds, may be placed at pre-determined locations and/or at pre-determined orientations on a base. In an embodiment, the pre-determined location and pre-determined orientation of the nodules on the base may be based on the foot size and the pressure points on the foot. In an embodiment, the base with a plurality of nodules may be placed on the base form the inner-sole, which may be placed in a footwear, for example shoes. In one embodiment, the shape and size of the plurality of nodules on the base may be uniform. In another embodiment, the shape and size of the plurality of nodules on the base may vary for a given user (human) based on several different factors. In an exemplary embodiment the size and shape of the plurality of nodules may vary depending on a user's specific requirements. In an embodiment, the pressure-points on the plantar surface of the foot may be determined and the inner sole may be customized having a base with a plurality of nodules that may be placed on the base at pre-determined locations and pre-determined orientations depending on the pressure points. The inner-sole with the plurality of nodules may be provided with a soft thin cushion, which may be placed over the plurality of nodule offering more comfort to the foot.

[0010] In an embodiment, customized inner soles may also be formed by determining pressure points of the foot exerted by a user, which may be different for the right foot and the left foot, and may also depend on factors such as the weight of the user, the walking style of the user and several other factors associated with a user. Based on the pressure points determined, a base may provide with a plurality of nodules forming an inner sole, which compensates the high-pressure points. In an embodiment, the plurality of nodules may be placed at a desired (calculated) location on the base and/or at a desired orientation on a base. In an embodiment, the base along with the plurality of nodules forms the inner sole, which may be placed inside a footwear and the inner-sole inside the footwear provides support for the foot.

[0011] In an embodiment, the inner sole advantageously reduces the pressure at these the high-pressure points or sore points on the plantar surface of the foot as the nodules at these high-pressure points or sore points may compress or snap on the inner sole thereby offloading the pressure at those points, instead of cutting and contouring the footwear. In another embodiment, the plurality of nodules may be coupled to each other in a particular format such that the pressure may be redistributed from one point on the inner sole to a different point on the inner sole, thereby providing support, stability and comfort to the user.

[0012] In an exemplary embodiment according to the present disclosure, a nodule includes a

first support and a second support, wherein the first support is aligned to be substantially parallel to the second support and first support and second support are separated by a pre-determined distance. The shape of the first support and second support may vary, but they are essentially the first support and the second support are made to be either rigid or of a pre-determined stiffness so as to not to allow any axial deformation or a very small axial deformation, such that the first support and the second support do not bend either inwards or outwards or bulge in any direction when an external force is applied on them. In an exemplary embodiment, the pre-determined distance between the first support and the second support may be determined based on the pressure points of the user's plantar foot surface or may be made by using a generic distance to separate the first support and the second support. In an exemplary embodiment, the nodules may be shaped in the form of an arch, which point in an upward direction (along the Z-axis) from the base (in the XY plane) between the first support and the second support (along the same axis of the first support and the second support).

15 [0013] In an exemplary embodiment, the arch of the nodule is coupled to the first support at one end and the second support at the other end. In an exemplary embodiment, the arch of the nodule may be coupled to an inner side (side facing the second support) of the first support on one end and on an inner side (side facing the first support) of the second support on another end. In an exemplary embodiment, arch may be coupled to the top of the first support on one end and the top of the second support on the other end. In an exemplary embodiment, a flat resting platform may be mounted on the arch. The first support, the second support, the arch and the resting platform together form a nodule in accordance with the present disclosure.

20 [0014] In an embodiment, the arch may be made flexible such that it may move in a vertical direction (Z-axis) bending in a downward direction between the first support and the second support when a pressure is applied on the flat resting platform of the nodule. This downwards bending offers a spring like action thereby taking off the pressure at these high-pressure points. In another exemplary embodiment, a plurality of such nodules may be connected or coupled with each other on a base such that they are configured to redistribute the pressure at one location to other location(s) on the inner sole. In an embodiment, when a pressure (force) is applied on the flat resting platform, the force is transmitted to the arch which is flexible and the arch moves in a downward direction, and at the same time ensuring that the first support and the second support holding the arch does not move or bulge sideways or there is no axial deformation of the first support and second support, and the arch moves back to its original

position (resting position) once the force is removed. Other embodiments are also disclosed

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] For a better understanding of the nature and desired objects of the present disclosure, reference is made to the following detailed description taken in conjunction with the accompanying drawing figures wherein like reference character/numerals denote corresponding parts throughout the several views. Objects, features, and advantages of embodiments disclosed herein may be better understood by referring to the following description in conjunction with the accompanying drawings. The drawings are not meant to limit the scope of the claims included herewith. For clarity, not every element may be labeled in every Figure. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating embodiments, principles, and concepts. Thus, features and advantages of the present disclosure will become more apparent from the following detailed description of exemplary embodiments thereof taken in conjunction with the accompanying drawings in which:

[0016] **Figure 1A** illustrates an exemplary nodule 100A in accordance with the present disclosure;

[0017] **Figure 1AA** illustrates an exemplary prototype 100AA of the nodule in accordance with the present disclosure;

[0018] **Figure 1B** illustrates another exemplary view of the nodule in accordance with the present disclosure;

[0019] **Figure 1C** illustrates an exemplary view of another prototype of the nodule 110C in accordance with the present disclosure;

[0020] **Figure 1D** illustrates an exemplary view of the nodule with a single arch and multiple arches in accordance with the present disclosure;

[0021] **Figure 2** illustrates an exemplary inner sole having a plurality of nodules placed at different locations and/or different orientations on a base in accordance with the present disclosure;

[0022] **Figure 3A** illustrates an exemplary inner sole made by using different shapes of the nodule in accordance with the present disclosure;

[0023] **Figure 3B** illustrates another exemplary inner sole made by using the nodule in accordance with the present disclosure;

[0024] **Figure 3C** illustrates another exemplary inner sole made by using the nodule coupled with connecting arches in accordance with the present disclosure

[0025] Figure 4A illustrates an exemplary use case where the inner sole with the nodules will provide proper support for the foot;

[0026] Figure 4B illustrates an exemplary use case of foot ulcers where the inner sole with the nodules will provide proper support for the foot especially at the point of high-pressure where ulcers are present;

[0027] Figure 5A is an exemplary illustration of preparing a nodule and affixing the nodules on a base forming an inner sole;

[0028] Figure 5B is an exemplary illustration of a preparing an inner sole with the nodules as a single unit; and

[0029] Figure 6 is an exemplary illustration of preparing a customized inner sole for a human foot.

DETAILED DESCRIPTION

[0030] Hereinafter, various exemplary embodiments of the present disclosure will be described with reference to the accompanying drawings, where it should be understood that all these drawings and description are only presented as exemplary embodiments. It is to be noted that based on the subsequent description, several alternative embodiments may be conceived that may have a structure similar to that disclosed herein and/or formed by a method as disclosed herein, and all such alternative embodiments may be used without departing from the principle of the disclosure as claimed herein, and hence such alternative embodiments are construed to fall within the scope of the present disclosure.

[0031] All references in the specification made to “one embodiment,” “an embodiment,” “a preferred embodiment” etc., indicate that the embodiment described herein may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases may not be necessarily referring to the same embodiment. It should also be understood that various terminology used herein is for the purpose of describing a particular embodiment or specific embodiments only and the use of such terminology is not intended to be limiting the scope and spirit of the present disclosure. As used herein, the singular forms “a,” “an” and “the” may also include the plural forms, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “has” and “including” used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence of one or more other features, elements, components and/or a combination thereof. For example, the term “multiple” used here indicates “two or more;” the term “and/or” used

here may comprise any or all combinations of one or more of the items listed in parallel. Definitions of other terms will be specifically provided in the following description. Furthermore, in the following description, some functions, or structures well-known to those skilled in the art will be omitted in order not to obscure embodiments of the disclosure in the unnecessary details.

[0032] It may be appreciated that these exemplary embodiments are provided only for enabling those skilled in the art to better understand and then further implement the present disclosure, not intended to limit the scope of the present disclosure in any manner. Besides, in the drawings, for a purpose of illustration, optional steps, modules, and units may be illustrated in dotted-line blocks.

[0033] Exemplary embodiments of the present disclosure relate to a nodule (which may also be referred to as a nodule structure or snapping support arch structure or snapping arch structure) and an inner sole for footwear which includes a plurality of such nodules. In an exemplary embodiment, the nodules may be created by three-dimensionally printing then using a 3D printer or may be prepared using a mold prepared, wherein the size and/or shape of the nodule is pre-determined. In an exemplary embodiment, a plurality of nodules may be affixed onto a base to form an inner sole, wherein the base is typically made to such that it may be suitable to fit a particular foot size. In an exemplary embodiment, the nodules may be formed by printing using a 3D printer or by a mold. In an exemplary embodiment, the nodules may be formed individually in different sizes and/or shape separately or may be formed in a group, wherein the nodules formed in a group may have the same size and/or shape, or the nodules may be formed in a group, wherein the nodules formed in the group may have different shapes and/or sizes. In an exemplary embodiment, the nodules may be printed or made in mold in a particular shape and/or size, or alternatively in different shapes and/or sizes as required by a user or as computed based on a user's requirements. In an embodiment, the nodules (plurality of nodules), for example, which may be 3D printed or molded, may be placed at pre-determined locations and/or at predetermined orientations on a base. In an alternate exemplary embodiment, the plurality of nodules may be placed at a computed location and/o computed orientation on the base based on a users' requirements. In an exemplary embodiment, the base along with the plurality of nodules forms the inner sole that may be used in a footwear. In an exemplary embodiment, the inner sole may be customized to a particular foot size and/or a particular foot shape of the user. In an exemplary embodiment, the inner sole may be made in a generic form to fit any particular size of the foot, where for example a generic inner sole may be made for an adult foot size 7 or adult

foot size 8. It should be obvious to a person of ordinary skill in the art that all sizes of footwear may be covered by the insole having the base and nodules of the present disclosure and all such sizes of footwear fall within the scope of the present disclosure.

5 [0034] In an exemplary embodiment, the shape and/or size of the plurality of nodules fixed on a base may be uniformly distributed over the base. In an alternate exemplary embodiment, the shape and/or size of the plurality of nodules may vary for a given user based on several different factors, for example pressure-points on the foot, where the plantar pressure for a user may be computed and the plurality of nodules may be placed at the pre-determined computed locations and a pre-determined computed orientations on a base forming the insole
10 for the users' footwear. In a further exemplary embodiment, a soft, thin cushion or padding may be placed over the plurality of nodules in order to offer a cushioning effect to the foot. In an embodiment, the position and orientation of the plurality of nodules on a base forming the inner sole may depend on a particular user's requirements. In an exemplary embodiment, the position and orientation of the plurality of nodules may be determined by measuring the
15 plantar pressure of the foot for a user, wherein the high-pressure points or sore points on the foot may be determined. In an exemplary embodiment, these pressure points may be different for the right foot and the left foot and may depend on factors such as the weight of the user, walking style of the user, the shape of the foot and several other factors that may be associated with the user. In an exemplary embodiment, the plurality of nodules forming the
20 inner sole may be built and made or fabricated in such a way as to compensate the pressure exerted by the foot due to these high-pressure points or sore points. In an exemplary embodiment, the plurality of nodules may be placed at a desired (calculated) location or pre-determined locations and/or a desired orientation or pre-determined orientation on a base, forming the insole, on which the foot may be rested, and due to the presence of the plurality
25 of nodules on the inner sole, the pressure on the foot is eased and the foot can be relaxed instead of being stressed.

[0035] In an exemplary embodiment, the inner sole (insole) may be formed by a base on which a plurality of nodules, having either uniform shape and/or size or different shapes and/or sizes, is positioned and then placed in a footwear, for example a shoe. In an exemplary
30 embodiment, the insole having the base on which the plurality of nodules may be affixed and suitably covered with a thin padding layer or a thin cushioning layer, which prevents direct contact of the foot with the plurality of nodules. In an exemplary embodiment, this type of customized footwear advantageously reduces pressure on the foot experience by these high-pressure points or sore points, and may also provide better stability and supported to the foot,

as the plurality of nodules may compress or snap at desired points (pressure points) thereby offloading the pressure at the high-pressure points. In another exemplary embodiment, the plurality of nodule may be coupled to each other in a particular format such that the pressure at one location may be redistributed from across the other points providing high stability and support to the foot.

[0036] In an exemplary embodiment, the nodules may be formed in series, such that two or more nodules may be coupled to each other forming a connected type of structure. In an exemplary embodiment, when two nodules are coupled to form a connected string of nodules, one nodule may be maintained at the same height of the other nodules and the other nodules may be placed at the lower location just above the support. In this exemplary case, because the nodules are coupled when pressure are exerted on the nodule which is at a height, the connected arch between the nodules moves in a way such that when one nodule goes down simultaneously the other nodules coupled s is lifted up, thereby redistributing the pressure applied at one are on the insole.

[0037] Figure 1A illustrates an exemplary nodule 100A (also referred to as snapping arch structure or nodule structure or retorting arch structure) in accordance with the present disclosure. Figure 1A also illustrates a prototype of a nodule 100AA in accordance with the present disclosure. The exemplary nodule 100A may include a first support 110 having an outer side 112 and an inner side 114. The exemplary nodule 100A further includes a second support 120 having an outer side 122 and an inner side 124. The inner side 114 of the first support 110 is aligned to be facing the inner side 124 of the second support 120, such that the first support 110 and the second support 120 are parallel to each other along an axis, for example the Z-axis and being formed/positioned on the XY plane. The first support 110 and the second support 120 are separated by a per-determined distance 115, which may be determined or computed by measuring the plantar pressure for a user or may be generic in nature. A first end 132 of an arch 130 is coupled to the first support 110 and a second end 134 of the arch 130 is coupled to the second support 120. The arch 130 is configured to point in an upward direction along the z-axis. The arch 130 is provided with a flat resting platform 140, which may be mounted on the top part of the arch 130.

[0038] The shape of the first support 110 and second support 120 may vary, but they are essentially fabricated and designed such that they have a pre-defined stiffness so as to allow an extremely small axial deformation along the XY plane (as illustrated in Figure 1C) or the stiffness is such that there is no axial deformation along the XY plane or the stiffness is such that they do not bend either inwards or outwards or bulge in any direction, particularly the

XY plane, when a force is applied on them along the z-axis (Figure 1A, prototype 100AA). In some embodiments, the first support 110 and the second support 120 may also be made to be rigid (Figure 1A prototype 100AA alongside). A force 150 may be applied on the flat resting platform 140, which in turn transfer the force via the arch 130 to the first support 110 and the second support 120. The height of the first support 110 and the second support 120 may vary in the range of 0.3 cm to about 2 cm. In an exemplary embodiment, the distance 115 between the first support 110 and the second support 120 may be a pre-determined depending on the size of the nodule and the number of nodules that may be required on the base to support the foot. The distance between the first support 110 and the second support 120 may vary in a range of 5 mm to about 9 cm. One exemplary method to determine the distance 115 between the first support 110 and the second support 120 may be by determining the pressure points of the user's foot, where a plantar pressure may be measured, and the size of the nodule and the distance 115 between the first support 110 and the second support 120, the height of the arch 130 and the dimension (width and length along the XY plane) flat resting platform 140 may be computed. In another exemplary case a generic nodule having a fixed distance 115 between the first support 110 and the second support 120, with a fixed height of the first support 110 and the second support 130, a generic height of the arch 130 and a generic dimension for the flat resting platform 140 may be constructed.

[0039] The nodules 110A may be provided with an arch 130, which is flexible and coupled at one end to the first support 110 and to the second support 120 at the other end. The arch 130 is made to point in an upward direction, along the z-axis, from the base (XY plane) between the first support 110 and the second support 120. The top of the arch 130 is provided with a flat resting platform 140. When a force 150 is applied on the flat resting platform 140, the arch 130 moves in a downward 155 along a vertical direction. along the z-axis, and when the force 150 is removed, the arch moves in an upward direction 155 long the vertical direction, along the z-axis, coming back to its original resting position, because the arch 130 is designed to be thin and flexible and has a spring like action. In an exemplary case, the movement of the arch 130 is directly proportional to the amount of pressure/force exerted on the flat resting platform 140.

[0040] In an exemplary embodiment, the arch 130 of the nodule 110A may be coupled to the first support 110 and the second support 120. In one exemplary embodiment, a first end 132 of the arch 130 may be coupled to an inner side 114 (side facing the second support) of the first support 110 and a second end 134 of the arch 130 may be coupled to an inner side 124 (side facing the first support) of the second support 120, making the arch 130 point upwards

along the z-axis. In another exemplary embodiment, a first end 132 of the arch 130 may be coupled to the top of the first support 110 and a second end 134 of the arch 130 may be coupled to the top of the second support 120, making the arch 130 point in an upward direction along the z-axis. A flat resting platform 140 may be mounted on the top of the arch 130 and the foot or part of the foot rests on the flat resting platform 140. When the foot rests on the flat resting platform 140, a force 150 is exerted on the flat resting platform 140. This amount of force 150 exerted on the flat resting platform 140 will vary across various points of the foot. For example, the heel and the part just after the toes would tend to exert the maximum pressure on the nodules in that region. Since the force 150 is different at different point of the foot, the compression of the arch 130 along the vertical direction 150 may be directly proportional to the force 150 on the flat resting platform 140.

[0041] The first support 110, the second support 120, the arch 130 and the resting platform 140 together form a nodule in accordance with the present disclosure. A plurality of such nodules 110A may be arranged on a base to form an inner sole on which the foot may be rested statically, or the nodules may dynamically move (while the user is in motion or walking) depending to the force exerted at that point of the insole compensating for pressure and providing comfort, stability and support to the foot. In another embodiment, two or more nodules may be coupled to each other to form a string of connected nodules, which can redistribute the force exerted on one nodule to other connected nodules.

[0042] In an exemplary embodiment, the arch 130 of the nodule 100A is designed to be flexible and may move in a vertical direction (z-axis) bending in a downward direction between the first support 110 and the second support 120, offering a spring like action thereby taking off the pressure at the high-pressure points or sore points on the foot. In an exemplary embodiment, a plurality of such nodules 100A may be connected to each other on a base such that the pressure is redistributed along the inner sole, i.e., pressure at one location to may be redistributed to other location on the insole when the plurality nodules are interconnected providing greater stability and support to the foot.

[0043] In an exemplary embodiment, the arch 130 may be designed to be flexible such that the arch 130 may move in a vertical direction 155 downwards in-between the first support 110 and the second support 120 when a force 150 is applied on the flat resting platform 140. When the force 150 is removed the arch 130 moves back in the vertical direction 155 upwards back to its resting position. The movement of the flat resting platform 140 is in along the z-axis, and the flat resting platform 140 is positioned along the XY plane. In an exemplary embodiment, a distance moved by the flat resting platform 140 is directly

proportional to the force 150 applied on the flat resting platform 140. In an exemplary embodiment, a position and orientation of the first support 110 and the second support 120 on the base is with a predefined stiffness or may be rigid such that the first support 1010 and the second support 120 remain fixed in position on application of the force 150 on the flat resting platform 140.

[0044] In an exemplary embodiment, a width of the arch 130 may be proportional to a number of arches coupled between the first support 110 and the second support 120 and supporting the flat resting platform 140. In an exemplary embodiment, the dimension of the flat resting platform 140 is variable and is normally equal to or smaller than the distance 115 between the first support 110 and the second support 120 and is mounted on top of the arch 130 in the XY plane.

[0045] In an exemplary embodiment, the first support 110 and the second support 120 may be shaped in either of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a hexagon or a heptagon or an octagon. In an exemplary embodiment, the shape of the flat resting platform 140 may be either one of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a hexagon or a heptagon or an octagon. In an exemplary case of Figure 1AA the first support 110 and the second support 120 are rectangular in shape, wherein the support is made of polycarbonate. In an exemplary embodiment, the nodule 110A includes material from at least one of an organic polymer and/or an inorganic polymer and/or a thermoplastic polyurethane and/or a poly carbonate and/or a fiber or a combination thereof. In a preferred embodiment, thermoplastic polyurethane and/or a poly carbonate may be used to form the nodule 100A.

[0046] In an exemplary embodiment, for the nodule may be printed using a 3D printer, wherein a tank is filled with the material and the material may be added with a required hardener to provide the prerequisite hardness to the printed part of the nodule or a different liquid may be used for each part of the nodule. In an exemplary case the entire nodule may be made using a single liquid thermoplastic polyurethane or polycarbonate. In another exemplary case, the first support and the second support may be made from a first liquid like polycarbonate and the arch and flat resting platform may be made from thermoplastic polyurethane. For example, the first support and the second support need to be stiff, and hence may require a hardening agent to be added to the material. On the other hand, the arch is required to be flexible, and hence materials that exhibit flexibility may be used. In another embodiment, a single material may be used, where the thickness of the support may be made such that the support are stiff and do not bend, whereas the arch may be made thin so that

they express a spring like action. In an exemplary embodiment, the nodule is printed as per the design required and printed layer by layer. In an exemplary embodiment, after printing each layer, the layer is dried/cured, and the next layer is printed on the dried layer until the nodule is completely formed. The thickness of the material is chosen to be stiffer for the support and is chosen to be flexible for the arches. In another exemplary embodiment, a mold may be prepared, and the material poured into the mold to form the nodule as per the required design.

[0047] In an exemplary case, where two or more nodules are connected to from a string of connected nodules, for example, considering two nodules coupled to each other in series, there will be in total two supports at the two ends and a support midway between the two supports, and a first nodule connecting one end support with the mid support and a second nodule connecting the other end support with the mid support. This forms two nodules with connecting arches and the height of the arches can be such that one nodule is formed with a height, wherein the arch is projected upwards and the other nodule is made as the same height as the height of the support, such that when a force acts on one nodule, the arch moves in a way to compress the first nodule and distribute the force to the second nodule, thereby lifting the second nodules and providing support to the regions around the area where the force is applied. When a pressure/force 150 is applied on the resting platform 140, the force 150 is transmitted to the nodule which moves in a downward direction and redistributes the force to the other nodules in the connected arch structure.

[0048] Figure 1AA is an exemplary prototype of a nodule 100AA in accordance with the present disclosure. All elements of the nodule 100AA are similar to the nodule 100A of Figure 1A as described above. However, in an exemplary case note that the stiffness of the first support 110 and the second support 120 is more such that the first support 110 and the second support 120 have practically no axial displacement along the XY plane when a pressure/force is applied on the z-axis. In the exemplary embodiment, the first support 110 and the second support 120, may be considered to be almost rigid or inflexible. In the exemplary embodiment, the first support 110 and the second support 120 are in the shape of a rectangular pillar and the arch 130 is connected to the inner wall 132 of the first support and the inner wall 134 of the second support 120. All other elements and functions are similar to the nodules as described in Figure 1A. A plurality of such nodules may be placed at pre-determined location and pre-determined orientations on a base forming the insole.

[0049] Figure 1B is an exemplary illustration of another view of the nodule 110B having a retorting arch structure in accordance with the present disclosure. As disclosed previously,

the nodule has a first support 110 and a second support 120, where the first support 110 placed at a pre-determined distance 115 from the second support 120. An inner side 114 of the first support 110 is facing an inner side 124 of the second support, such that the first support 110 is aligned parallel to the second support 120 along an axis (z-axis). In the exemplary case, the first support 110 and the second support 120 are triangular in shape (right angled triangle), wherein the angular side of the support are facing each other and the right-angled side are on the farther side aligned parallel to each other. The first support 110 and the second support 120 are provided with a required stiffness such that they is no axial displacement along the XY plane when a pressure is applied along the z-axis. In an exemplary embodiment, a first end 132 of an arch 130 coupled to the first support 110 and a second end 134 of the arch 130 coupled to the second support 120, and the arch 130 projects upwards along the z-axis. In an exemplary embodiment, a flat resting platform 140 mounted on top of the arch 130. As illustrated, the bottom of the first support 110 may have a base 115 that is made to support to the first support 110, and the bottom of the second support 120 may have a base 125 that is made to support the second support 120. The base 115 and the base 125 may be thicker than the supporting structures itself and may be made in different shapes, which can be then affixed on a base for the inner sole. In an exemplary embodiment, the base 115, 125 may be triangular, square, rectangular, pentagonal, octagonal. or any other shape. It should be obvious that various shapes may be possible for making the first support and the second support and all such shapes fall within the scope of the present disclosure. As illustrated in exemplary Figure 1B, the base 115 of the support 110, 120 is triangular in shape towards the inner side of the first support 110 and the inner side of the second support 120 between the distance 115, providing greater stability and strength to the first support 110 and the second support 120. It should be obvious to one of ordinary skill in the art the base 115, 125 for the first support 110 and second support 120 may be thicker than the top part of the first support 110 and the second support 120 in order to provide greater stability and strength and ensure that the first support 110 and the second support 120 do not collapse when a force 150 applied.

[0050] Figure 1C illustrates an exemplary view of a prototype of the nodule 110C in accordance with the present disclosure. In an exemplary embodiment, the nodule 100C as illustrates was 3D printed using thermoplastic polyurethane. As disclosed previously a variety of material may be used to make these nodules and all such material fall within the scope of the present invention. The nodule 110C has a base 105, on which a first support 110 and a second support 120 have been formed. As illustrated in the Figure, the bottom part 115 of the

first support 110 and the bottom part 125 of the second support is triangular in shape and thicker than the top part, which essentially provides greater stability and strength to the nodule 110C. In this exemplary embodiment, the base 115 of the first support and the base 125 of the second support are triangular in shape, and are printed on top of the base 105. In the Exemplary case both the first support and the second support are triangular in shape, with the angled part pointing inwards between the pre-determined distance and the right-angled part facing outwards, and the first support and the second support being substantially parallel to each other. It should be obvious to one of ordinary skill in the art that various other shapes may be possible for the support with a required stiffness and all such shapes fall within the scope of the present disclosure. A flexible arch 130 is made, for example by printing or by a mold, above the first support 110 and the second support 120 having a pre-determined height. One end of the arch 130 is coupled to the top part of the first support 110 and the other end is coupled to the top end of the second support 120. The arch 130 is provided with a flat resting platform 140 on which a part of the foot may rest and the pressure of the foot at that point exerts a force 150 on the flat resting platform 140. The force 150 causes the arch 130 to move in a downward vertical direction 155 (along the z-axis), and when the force 150 is removed, the arch 130 moves back in an upward vertical direction 155 back to its normal resting place. The arch is constructed in the XY plane and projected along the Z axis.

[0051] Figure 1D illustrates an exemplary view of the nodule with different type of arch structures in accordance with the present disclosure. As disclosed previously, each nodule may have a first support 100 and a second support 120, which then supports an arch 130 and a resting platform 140. In an exemplary embodiment, the arch 130 may be a single arch 130A, or may be a plurality of arches 130B, 130C. A width of the arch 30A, 130B, 130C may depend on the number of arches coupled between the first support 110 and the second support 120 and the thickness/width of the first support 110 and the second support 120 may determine the number of arches that may be formed. Ideally, in case of multiple arches between the first support and the second support, each arch is separated by a small/narrow gap. The more the arches between the first support and the second support, the thinner would be the width of the arch. The arches may be made flexible and strong so that they move in a vertical direction downwards when a force is applied on the resting platform 140, and move in a vertical direction upwards when the force is removed. Also, as discussed previously, each of the first support 110 and the second support 120 may have a base that is thicker in dimension such that the support 110, 120 at the top such that the support 110, 120 does not bend or bulge outwards or collapse inwards when a force is applied and the plurality of

arches 130 move in a downward direction. In an exemplary embodiment, a single arch 130A between the first support 110 and the second support 120 may be as wide as the width of the support 110, 120. In an further exemplary embodiment, multiple arches 130B, 130C coupling the first support and the second support will be smaller in width and may be separated by a gap such that each of the multiple arches is flexible and is arch as a whole able to take the load/force applied on the resting platform 140.

[0052] Figure 2 illustrates an exemplary inner sole (insole) made by using a plurality of nodules placed at different pre-determined locations and different pre-determined orientations on a base in accordance with the present disclosure. In a generic case a base 260 may be first made either by 3D printing method or using a mold for a given foot size. Once the base 260 is formed, in an exemplary embodiment, the nodules 110A may be printed on the base in a pre-determined orientation and at a pre-determined location forming the inner sole 200. In another exemplary embodiment, the nodules 110A may be printed and affixed on the base 260 at pre-determined locations and/or pre-determined orientations forming the inner sole. In an alternate embodiment, the nodules 110a may be formed using a mold and then affixed on the base at pre-determined locations and pre-determined orientations on the base 260. The inner sole (Insole) 200 may be provided with a thin cushion or padding 270 on top as a support. A single nodule 100AB from amongst the plurality of nodules 100A placed on the base 260 is illustrated alongside, and these nodules are similar to the nodule as discussed previously with respect to Figures 1A, Figure 1B and Figure 1C.

[0053] In another exemplary embodiment, the plantar pressure of a user's foot may be first determined, and based on the pressure point of the foot, a position and an orientation for each nodule on a base and the size and shape of each nodule may be determined. The nodule may be printed accordingly using 3D printing or may be formed using a mold and then affixed onto the base. The arrangement of the nodules (location/position and orientation) on the base may vary depending on the pressure experience by a user. In a generic case, the nodules 110A may be placed at fixed locations and fixed orientation determined such that the general plantar pressure experienced by the foot is reduced to a great extent. In an exemplary case, the heel part may be provided with stronger nodules to absorb shocks to that part of the foot.

[0054] In another exemplary embodiment, the plurality of nodules may be coupled to each other along a particular direction in the XY plane, such that the force applied by the foot at one point may be redistributed on other nodules on the base. In one exemplary embodiment, the flat resting platform 140 may be provided with a coating of a magnetic material to provide magnetic therapy to the foot in addition to massaging the foot. In an exemplary

embodiment (not illustrated in the figure), the nodules may be coupled to a battery source, and when powered on the nodules may be configured to move in a particular manner and massage the foot, and the movement of the nodules may be pre-programmed.

[0055] Figure 3A illustrates an exemplary inner sole (insole) made by using different shapes of the nodules in accordance with the present disclosure. The exemplary insole includes a base 305A divided into three sections, the heel part of the foot, the toes part of the foot and the middle part of the foot, the middle part falling between the heel and the toes. Each section may be designed to have different types of nodules (shapes) and dimensions of nodules (sizes), where each of the nodules have a support 310A (includes both the first support 110 and second support 120, and broadly referred to as support), with a pre-defined or required stiffness such that they do not axially deform when a pressure is applied, and may yet be flexible. In the exemplary illustration 300A, the base 305A is divided into three sections, the toes section 301A, the middle section 302A and the heel section 303A. It should be obvious to one of ordinary skill in the art, that the base may be divided into more than three or less than three section as illustrated herein, and the number of sections may be dependent on the size of the foot and/or the pressure points on the foot. The first section 301A has two nodules with the support 310A (includes the first support and the second support) and each nodule having an arch 330A and a flat resting platform 140. In this exemplary case the toes section 301A has an array of flexible arch on which a flat resting platform is provided. The resting platform 140 on the first section 301A is circular or oval in shape.

[0056] In the exemplary illustration of 300A, heel section 303A has a single nodule, which is larger in size compared to the nodules in the foot section and is octagonal in shape. The construction of the nodule remains the same, the first support, second support, and flexible arches 330A connected between the first support and the second support and a flat resting platform on top of the arch 330A. The middle section 302A, between the toe section 301A and the heel section 303A is provided with a single large arch 330A that supports the mid-section of the foot which includes the arch of the foot between the toes and the heel. As illustrated in exemplary insole 300A, the shape and size of the nodules may vary between the various section of the foot. Notably, in the exemplary embodiment, the shape and size of the nodules in each of the toe section 301A, the mid-section 302A, and the heel section 303A may be varying and may be made as generic in nature or may be customized for a particular user based on the plantar pressure exerted by the user. In an exemplary embodiment, the toe section and the middle section may be formed by a connected arch structure, wherein the pressure applied on the toes region lift and support the curve in the middle region providing

greater stability to the foot.

[0057] Figure 3B illustrates another exemplary embodiment of an insole in accordance with the present disclosure. As illustrated the insole 300B has three section or is divided into three section the heel section 303B, the mid-section 302B and the toes section 301A. Each of the sections has a plurality of nodules 100A placed at pre-determined location and in a pre-determined orientation, which may be based on generally available data or made in a customized manner by measuring the plantar pressure on a users' foot. As illustrated in the insole 300B, each nodule has a first support and second support, generally shown as support structures 310B. Each nodule will have a flexible arch or plurality of arches 330B coupled between the support 310B (coupled between the first support and the second support of the nodule). The base of the insole 305 is affixed with a plurality of nodules in a pre-determine location and a pre-determined orientation in each of the regions so as to reduce the pressure of the foot. The insole may be provided with a cushion or thin padding when placed inside a footwear such as a shoe.

[0058] Figure 3C illustrates another exemplary insole 300C having a different architecture of connected arches in accordance with the present disclosure. In this exemplary insole, the base 305C may be divided into three regions, the heel region, the mid-section and the toe region. Each of the region may be provided with a coupled nodule cluster 301C, 302C or certain section 303C with a single nodule affixed therein. Each single nodule has the same structure as disclosed previously with respect to Figure 1A. However, the insole 300C may be advantageously formed with coupled nodules, wherein at least two or more modules are coupled. In an example case, the section 301C and section 302C illustrate coupled nodules being provided on the insole instead of single nodules. The coupled nodules as illustrated in Section 302C is projected outwards in Figure 3C. Each section having coupled nodules 301C, 302C. The projected section 302C shows a set of coupled nodules. Each of the coupled nodules has at least two nodules coupled between the support. The architecture 302C has two nodules and 3 supports, a first support 311C, a second support 312C and a third support 313C, which is midway between the first support 311C and the second support 312C. In this type of nodule architecture, a first arch is couple between the first support 311C and the mid support 314C, and a second arch is coupled between the mid support 313C and the second support 312C. The first arch 331C between the support 311C and the mid-support 313C is pressed downwards and the second arch 332C between the mid-support 313C and the second support is pointed upwards and is above the height of the midway support 313C and the second support 312C.

[0059] In this type of connected arch 331C, 332C architecture, when the foot is placed on the resting platform of arch 332C, the force is redistributed along the arch between the first support 311C and the second support 312C, the second arch 332C moves downwards and the first arch 331C moves upwards providing support to the regions around the first arch 331C and the second arch 332C. This type of architecture may generally find used in patients with diabetes having ulcerated foot as illustrated in Figure 4B.

[0060] Figure 4A illustrates an exemplary use case where the inner sole with the nodules will provide proper support for the foot. Noticeably, the left foot 410 is straight but the right foot 420 of the user at the heel portion is twisted. This can result in causing temporary or permanent damage to the foot at the heel. Ideally placing an insole as disclosed in accordance with the present disclosure inside the shoe will result in providing stability and support to the foot and present such issues with the foot as the foot would tend to remain straight and hence the shoe would also remain straight, providing support to the user and higher stability and life to the shoe.

[0061] Figure 4B illustrates an exemplary use case of foot ulcers where the inner sole with the nodules will provide proper support for the foot especially at the point of high-pressure where ulcers are present. In the present case ulceration is shown at different stages of a diabetic foot. As illustrated, in a person with a diabetic history, first an open lesion 430 is first formed on the sole of the foot. The open lesion 430 then gradually becomes a superficial ulcer 440. If care is not taken at these initial stages, then the superficial ulcer 440 then becomes a deep ulcer 450. From this the deep ulcer 450 then graduates to becoming an abscess osteitis 460, then progressing to gangrene forefoot 470 and finally a gangrene foot 480. If proper care is taken at the initial stages of identification of these ulcers and treating these ulcers by using an insole as described in Figure 2 or Figure 3, the advanced stages for these ulcers may be prevented, and because the insole is designed to remove pressure from certain areas and/or provide magnetic therapy and/or massage the ulcerated parts may heal and cure faster and the foot is also rested at comfort when static or in motion, as the movement of the arch 130 would depend on the pressure exerted at that point of the foot. Many other examples and uses case of the insole are possible and all such are not disclosed in the present disclosure, but should be obvious to one of ordinary skill in the art, that such an insole as described herein with nodules may be used for other foot health related issues or even spinal issues. In an exemplary embodiment, the insole as disclosed may be advantageously customized and used to absorb spinal shocks towards the heel section of the foot and remove stress at those point experiencing high-pressure.

[0062] Figure 5A is an exemplary illustration of preparing a nodule and affixing the nodules on a base forming an insole. In step 510 the first support 110 and second support 120 are designed and formed or created using a 3D printing methodology. The first support 110 and the second support 120 are separated by a pre-determined distance 115 from each other, and are aligned parallel to each other along the Z-axis, as disclosed previously. The first support 110 and the second support 120 are formed such that they are having a pre-defined stiffness or are at least rigid in structure such that they do not bend or bulge or collapse or have an axial displacement in the XY plane when a force is applied on them. Once the first support 110 and the second support 120 are formed to a desired height and in a desired shape, in Step 420 an arch 130 is the formed using the same 3D printing methodology, wherein the arch could be a single arch 103A or an array of arches 130B, 130C, and the arch 130 or array of arches is flexible, as has been disclosure previously. A first end 132 of the arch (or arches) is coupled to the first support 110 and at a second end 134 of the arch coupled to the second support 120. The arch 130 is formed in a way such that it points in an upward direction along the Z-axis from the XY plane or the base. After the arch or array of arches is formed, in step 430 the resting platform 140 is formed, as has been disclosed previously, using the same 3D printing methodology. The first support 110, the second support 120, the arch 130 and the resting platform 140 thus form a nodule 110A. The nodule thus formed, in step 440 is affixed on a base 105. A plurality of nodules may be affixed on the base 105 at pre-determined locations and pre-determined orientations to form an insole. In an embodiment, the nodule 110A may be formed along with the base, i.e., the base and the nodules may be printed using the 3D printing methodology. The material used for printing may include at least one of an organic polymer and/or an inorganic polymer and/or a thermoplastic polyurethane and/or a poly carbonate and/or a fiber or a combination thereof. The shape and size of the nodules may be either one of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a hexagon or a heptagon or an octagon.

[0063] In 3D printing techniques/methodology, each nodule or the insole may be printed layer by layer. First one layer is printed on a substrate and the printed layer is cured as the printed layer is wet. Once the wet printed layer is cured the next layer is printed on the cured layer, and the process of printing and curing is repeated until the complete nodule or the base and the nodules are printed using a 3D printing technique.

[0064] Figure 5B is an exemplary illustration of preparing a nodule and affixing the nodules on a base forming an insole. In step 550 first a design for the nodule is determined and a mold is made as per the design of the nodule. In step 560 the material is poured into the mold and

left to cure molten material is left to cure in the mold. This may be done/repeated in several steps thereby first forming the support 110, 120, then forming the arch 130 and then forming the resting platform 140. As described previously, the support 110, 120 are rigid or have a pre-defined stiffness and the arch 130 is flexible. The shape and/or size may vary for the support 110, 120, for the arch 130 and for the resting platform 140. Once the nodule 110A is created with a mold, a plurality of such nodules may be affixed to a base 105 to form the insole. In an exemplary embodiment, the nodule may be formed in the mold with the base 105 in a single arrangement.

[0065] The material used for creating the insole in the mold may include at least one of an organic polymer and/or an inorganic polymer and/or a thermoplastic polyurethane and/or a poly carbonate and/or a fiber or a combination thereof. The shape and/or size of the nodules may be either one of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a hexagon or a heptagon or an octagon.

[0066] Figure 6 illustrates an exemplary embodiment of preparing a customized insole in accordance with the present disclosure. In step 610, a size of a foot for a user is determined or computed. In step 620, the pressure point of the foot may be determined, i.e., the high-pressure points or ulcerated points on the foot, in addition to other pressure points and any sore points. In step 630, the position and orientation of the nodules for the user is determined based on the determined pressure points, and on other parts of the foot, the nodules may be placed based on generally available data. In step 640 a base 260 is formed using 3D printing techniques or a mold and in step 650 the nodules are formed using the 3D printing technique or the mold at the desired location and orientation on the base. The material used for creating the insole may include at least one of an organic polymer and/or an inorganic polymer and/or a thermoplastic polyurethane and/or a poly carbonate and/or a fiber or a combination thereof. The shape and/or size of the nodules may be either one of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a hexagon or a heptagon or an octagon.

[0067] In an alternate embodiment, once the location and orientation of the nodules may be determined in step 630, a mold may be prepared accordingly, having a base of the size of the foot and the nodules at the appropriated positions and orientations determined, and the material may be poured into the mold and cured in the mold to create the insole. In an alternate embodiment, the position and orientation of the nodules may be kept in a generic manner and the nodules and base may be printed or molded. It should be obvious to one of ordinary skill in the art that several other techniques may be used to create a nodule and affix

such nodules on a base or create an insole as described herein, and all such techniques fall within the scope of the present disclosure.

5 [0068] In the method described in Figure 5A, Figure 5B and Figure 6, the distance 115 between the first support and the second support may be pre-determined or may be generic using standard distances. The shape and/or size of the nodules may be pre-determined or may be generic or may be based for example on the user's customary requirements. The inner sole may be provided on top with a thin cushion layer or a thin padding when inserted into the shoe or footwear for use.

10 [0069] Although the operations of the method according to the embodiments of the present disclosure are described in a specific order in the drawings, it does not require or imply that these operations have to be performed in that specific order, or a desired result can only be achieved by performing all of the illustrated operations. On the contrary, the steps illustrated in the flow diagrams may change their execution order. Additionally, or alternatively, some steps may be omitted, a plurality of steps may be combined into one step for execution, 15 and/or one step may be decomposed into a plurality of steps for execution. It should also be noted that the features and functions of two or more modules according to the embodiments of the present disclosure may be embodied in one module. In turn, features and functions of one module described above may also be further divided into a plurality of modules for embodiment.

20 [0070] Although the present disclosure has been described with reference to several preferred embodiments, it should be understood that the present disclosure is not limited to the preferred embodiments disclosed here. Embodiments of the present disclosure intend to cover various modifications and equivalent arrangements within the spirit and scope of the appended claims. Although the foregoing disclosure has been described in some detail for purposes of clarity of understanding, it will be apparent that certain changes and 25 modifications may be practiced within the scope of the appended claims. Examples of the present disclosure have been described in language specific to structural features and/or methods. It should be noted that there are many alternative ways of implementing both the process and apparatus of the present invention. Accordingly, the present embodiments are to be considered illustrative and not restrictive, and the invention is not to be limited to the 30 details given herein but may be modified within the scope and equivalents of the appended claims. It should be understood that the appended claims are not necessarily limited to the specific features or methods described. Rather, the specific features and methods are disclosed and explained as examples of the present disclosure.

We Claim:

1. A nodule 100A, the nodule comprising:
a first support 110 and a second support 120, the first support 110 placed at a pre-determined distance 115 from the second support 120, wherein an inner side 114 of
5 the first support 110 facing the inner side 124 of the second support along a two-dimensional (XY) plane, such that the first support 110 is aligned substantially parallel to the second support 120 along a third (z) axis;
a first end 132 of an arch 130 coupled to the first support 110 and a second end 134 of the arch 130 coupled to the second support 120, wherein the arch 130 projects above
10 the first support 110 and the second support 120 along the third axis; and
a flat resting platform 140 mounted on top of the arch 130 along the two dimensional plane.
2. The nodule as claimed in claim 1, wherein the arch 130 is flexible and the arch 130
15 configured to move responsive to a force applied on a flat resting platform 140 by transmitting the force to the arch 130, wherein the arch 130 moves in a vertical direction 155 downwards along the third axis on application of a force 150 and upwards along the third axis to its original resting position on removal of the force 150.
3. The nodule as claimed in claim 3, wherein a width of the arch 130 in a nodule 100A
20 is proportional to a number of arches 130A, 130B, 130C coupled to the first support 110 and the second support 120.
4. The nodule as claimed in claim 1, wherein the size of the flat resting platform 140 in
the two-dimensional plane is variable and is equal to or smaller than the distance 115
25 between the first support 110 and the second support 120; and the shape of the flat resting platform 140 is either one of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a hexagon or a heptagon or an octagon or a combination thereof.
5. The nodule as claimed in claim 1, wherein the shape of the first support 110 and the
30 second support 120 is either one of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a hexagon or a heptagon or an octagon or a combination thereof.

6. The nodule as claimed in claim 1, wherein the nodule comprises a material including at least one of an organic polymer, an inorganic polymer, a thermoplastic polyurethane, a poly carbonate, / a fiber or a combination thereof.
7. An insole 200, 300C comprising the plurality of nodules 100A as claimed in any of the claims 1 to 6 mounted on a base 260, wherein each of the plurality of nodules 100A are affixed at a pre-determined location and orientation on the base 260.
8. The insole as claimed in claim 7, wherein the pre-determined location and the pre-determined orientation may be computed based on a plantar pressure measurement of a user.
9. The insole as claimed in claim 7, wherein the plurality of the nodules 100A affixed to the base 260, 305A is either of a uniform size, a variable size or a combination thereof.
10. The insole as claimed in claim 7, wherein the plurality of nodules 100A are coupled along an axis and a plane to redistribute the plantar pressure across the connected plurality of nodes.
11. The insole as claimed in claim 10, wherein at least two nodules 331C, 332C are connected such that the first nodule 331C is coupled between a first support and a midway support and the second nodule 332C is coupled between the midway support and a second support.
12. The insole as claimed in claim 11, wherein a resting position of the first nodule 331C is a point below and between the first support and the midway support, and a resting position of the second nodule 332C is a point above and between the first support and the midway support.
13. The insole as claimed in claim 11, wherein a force applied on the second nodule 332C is transmitted with the arches connecting the first nodule 331C and the second nodule 332C, and the second nodule 332C moves in a downward direction and the first nodule 331C moves in an upward direction compensating the force applied on the second nodule 332C.
14. A method for preparing a nodule 100A, the method comprising:
forming a first support 110 and a second support 120 along a z-axis in a three-dimensional place, wherein a distance 115 between the first support 110 the second support 120 is pre-determined, and the first support 110 being aligned substantially parallel to the second support 120, wherein a shape and a size of the first support 110

and the second support 100 is pre-determined, and a height of the first support 110 and the second support 120 is pre-determined;

on completion of printing the first support 110 and the second support 120 to a desired height along the z-axis, forming an arch 130, wherein the arch 130 is coupled to the first support 110 and the second support 120, and the arch is in an upward direction along the z-axis;

on completion of forming the arch 130, forming a resting platform 140, wherein the size of the resting platform 140 is equal to or smaller than the distance between the first support 110 and the second support 120.

15. The method as claimed in claim 14, wherein a plurality of nodules is affixed on a base 260 at a pre-determined location and pre-determined orientation forming an insole.

16. The method as claimed in claim 14, wherein the shape of the first support 110 and the second support 120 is either one of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a sexton or an octagon or a combination thereof; and the shape of the flat resting platform 140 is either one of a triangle or a square or a rectangle or a circle or a semicircle or an oval or a trapezoid or a pentagon or a hexagon or a heptagon or an octagon or a combination thereof.

17. The method as claimed in claim 14, wherein the nodules and the base comprises a material including at least one of an organic polymer, an inorganic polymer, a thermoplastic polyurethane, a poly carbonate, a fiber or a combination thereof.

18. The method as claimed in claim 14, wherein forming the first support 110 and the second support 120 comprises:

forming a first layer of the first support 110 and a first layer of the second support 120 on a substrate;

curing the first layer by exposing the first layer to heat and light;

forming the next layer after curing the first layer; and

repeating the steps of curing the first layer and forming the next layer until the first support 110 and the second support 120 of a desired height are formed.

19. The method as claimed in claim 14 for forming the arch 130 and flat resting platform 140, the method comprising:

forming a first layer of the arch 130 wherein a first end 132 of the arch 130 is coupled to the first support 120 and a second end 134 of the arch 130 is coupled to the second support 120;

curing the first layer of the arch 130;
forming the next layer of the arch 130, wherein the next layer is dimensionally smaller than a previously layer;
curing the next layer;
5 repeating the step of forming the next layer and curing the layer until the arch is formed; and
on completion of forming the arch 130, forming the flat resting platform 140 on the arch 130 and curing the flat resting platform 140.

20. The method as claimed in claim 14, comprising:

10 affixing the plurality of the nodules 100A at a pre-determined location and at a pre-determined orientation on a base 260.

21. A method for preparing a customized insole as claimed in claim 7, wherein the method comprising:

15 determining pressure point of a user on a foot;
determining a dimension of the foot;
choosing a base based on the size of the foot;
choosing at least one pattern for a nodule;
choosing a size and a shape for each the nodule;
choosing a size and a shape for the flat resting platform;
20 choosing a location and an orientation for each of the nodules to be formed on the base; and
forming the base and the plurality of nodules at the location and orientation on the base, forming a complete customized inner sole.

25