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(54) MIDSOLE WITH A SHEARING STRUCTURE FOR A SHOE AND METHOD OF MANUFACTURING THEREOF

(57) The present disclosure relates to a sole (101) for a shoe, in particular for a sports shoe, such as a running shoe, the sole (101) comprising: a midsole (110) comprising an upper midsole layer (120) and a lower midsole layer (125), the upper midsole layer (120) and the lower midsole layer (125) being distinct from one another; and a shearing structure (130), arranged in the midsole (110); wherein the shearing structure (130) is configured to allow a relative movement between the upper midsole layer (120) and the lower midsole layer (125).

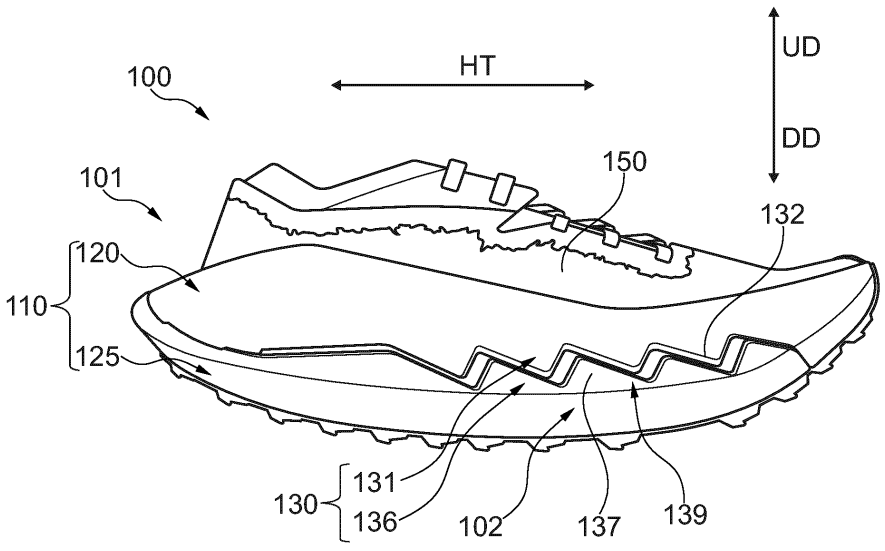


Fig. 7

EP 4 541 212 A1

Description

1. Technical field

[0001] The present disclosure relates to a sole for a shoe, in particular for a sports shoe, such as a running shoe. In particular, the present disclosure relates to a sole comprising a midsole and a shearing structure to allow for a relative movement between an upper midsole layer and a lower midsole layer of the sole. The present disclosure also relates to a respective shoe, comprising such a sole. Further, the present disclosure relates to a respective method for manufacturing a sole for a shoe.

2. Prior art

[0002] Soles for shoes, in particular soles for sports shoes, such as running shoes are generally known, have various purposes and use cases, and have been becoming more and more popular among individuals. A shoe sole typically serves several different functions in order to be even more attractive to individuals.

[0003] For example, shoe soles usually serve protective purposes, for example, to protect a wearer's foot from interferences or disturbances from foreign objects, such as sharp or pointed objects on which the wearer may tread. Further, a sole for a shoe usually facilitates cushioning of the impact forces occurring upon foot strike. A shoe sole also provides for traction to avoid slipping of the wearer's foot. In addition, a shoe sole typically provides a degree of stability to the wearer's foot, so that the danger of twisting one's ankle or other kinds of injuries, for example injury to the plantar fascia or muscle overloading, etc., can be reduced. Yet a further function of a shoe sole, particularly for performance footwear like running shoes, is to facilitate a good transmission of forces from the athlete's legs through their feet to the ground and an efficient running style, to improve the athlete's performance. Furthermore, in particular for sports shoes, the foot of the athlete should be sufficiently cushioned in order to reduce impacts and loads on joints of the athlete. In addition, a shoe sole should be as light as possible to further contribute to reduce energy consumption for the athlete, which is for instance relevant at longer distances.

[0004] Some particularly relevant needs in this context are that on the one side a high degree of cushioning and stabilization should be reached to reduce the risk of injuries and to make an athletic activity more comfortable. On the other side, a high energy return should be ensured to reduce the amount of energy that is necessary for the athlete at the same time.

[0005] In this context, the following exemplary prior art documents may be mentioned.

[0006] Prior art document US 2004 / 0 154 188 A1 relates to an athletic shoe midsole including a hard elastic stabilizing member that extends generally around a central opening through which a relatively soft elastic cushioning layer extends downwardly from a heel center beneath a wearer's calcaneus bone to thereby form a heel-cushioning pillar. The stabilizing member extends along lateral and medial sides of the pillar to prevent pronation and supination, and preferably includes a protrusion that extends into a depression in the heel-cushioning pillar in alignment with a line of flexure of the heel region to thereby affect flexure characteristics of a heel region of the shoe. The midsole may also include flex grooves, channels, and / or notches aligned with the line of flexure for promoting the desired flexure characteristics in the heel region of the sole and for helping decelerate the wearer's heel-toe gait during the stance phase of the wearer's gait cycle.

[0007] Prior art document WO 2023 / 005 966 A1 relates to sports shoe and a midsole system, the midsole system comprising: a first midsole, the first midsole being made of a cushioning material; an outsole, a buffer space being formed between the first midsole and the outsole; an elastic piece positioned in the buffer space, the elastic piece being capable of elastically deforming along the direction of arrangement of the first midsole and the outsole; the elastic piece has a heel part positioned in the heel area of the midsole system and a forefoot part positioned in the forefoot area of the midsole system. The cushioning mode of the first midsole is material cushioning, and the cushioning mode of the elastic piece is structural cushioning; during use of the midsole system, both the first midsole and the elastic piece can absorb impact force from the ground (the impact force along the direction of arrangement of the outsole and the first midsole), thereby effectively improving the cushioning performance and rebound performance of the midsole structure.

[0008] Prior art document US 2022 / 0 312 891 A1 relates to a sole structure including a first midsole portion, a second midsole portion disposed below the first midsole part, and a support plate stacked between the first midsole portion and the second midsole portion, disposed at a location corresponding at least to a hindfoot portion, and having a higher rigidity than the first midsole portion and the second midsole portion. The support plate includes: a base portion having a corrugated shape with at least one peak and at least one valley; and first and second support portions having a corrugated shape and branched apart from each other from a peripheral edge portion located on an inner side of the base portion toward the first midsole portion and the second midsole portion, respectively. The valley of the second support portion is disposed at a location corresponding to a sustentaculum tali.

[0009] Further prior art is disclosed in DE 10 244 435 B4, US 8 387 279 B2, US 8 453 344 B2, CN 2 18 898 566 U, CN 1 12 716 098 A, US 2021 / 0 227 927 A1, US 11 000 094 B2, US 8 863 407 B2, US 11 470 912 B2, US 11 510 457 B2, and US 4 614 046 A.

[0010] The proposed solutions still have some deficiencies when it comes to providing the above identified needs. For instance, most of the known solutions are

focusing on heel striking and require bulky additional components for cushioning. Further, they do not yield optimum results for energy return. Moreover, high performance lightweight foams may provide more deformation, and, hence, cushioning, however, the higher energy return associated with these foams negatively impacts loads on knees or the like of athletes.

[0011] Against this background, it is an object of the present invention to provide an improved sole for a shoe that overcomes the deficiencies of the prior art at least partially. In particular, it is an object of the present invention to provide a sole for a shoe that allows for improved cushioning and to dampen the impacts to the foot of the wearer. It is a general object to reduce the risk of injuries. It is a further object to provide a method for manufacturing such a sole for a shoe. It is a general objective to reduce costs in providing such a sole for a shoe.

3. Summary of the invention

[0012] The above-mentioned objects are at least partially achieved by the subject-matter of the independent claims. Preferred embodiments are subject of the dependent claims, and other suitable aspects of the present invention are described through the overall disclosure of the present application.

Sole for a shoe

[0013] In one aspect, the objects are solved by a sole for a shoe, in particular for a sports shoe, such as a running shoe, the sole comprising: a midsole comprising an upper midsole layer and a lower midsole layer, the upper midsole layer and the lower midsole layer being at least partially distinct from one another; and a shearing structure, arranged in the midsole; wherein the shearing structure is configured to allow a relative movement between the upper midsole layer and the lower midsole layer.

[0014] In this manner, the sole for a shoe, in particular for a sports shoe facilitates improved cushioning to the wearer, which is useful for any kind of athletic activity. At the same time, enough energy return can be achieved, although not to such an extent that could adversely affect the running experience. The improved cushioning reduces loads and impacts on any joints of the wearer. Thereby, the risk of injuries can be significantly reduced. For instance, the impacts on the knees and ankle joints may be reduced, which is of importance for instance during downhill running. In addition, muscle damage and fatigue can be reduced since the overall impacts can be dampened. Hence, the wearer may perform any athletic activity for a longer period and / or with a better result. It was found that the advantages are particularly pronounced at first ground contact and / or after first ground contact of the sole. Thereby, forces, in particular horizontal forces can be reduced. Overall, this may lead to a reduction of the kinetic energy as described elsewhere herein.

[0015] Without wishing to be bound by theory, it is believed that the advances of the sole for a shoe as proposed in here are among others based on the following principles. The relative movement of the upper midsole layer and the lower midsole layer may cause sliding of the upper midsole layer and the lower midsole layer. Such sliding may cause frictional forces that act against the direction of the sliding movement. For instance, forces due to sliding friction may act against the direction of the sliding movement. The sliding friction may generally be referred to as solid body friction.

[0016] The sliding friction may comprise static friction, rolling friction and / or dynamic friction. Thereby, while some relative movement is allowed by way of the shearing structure, at the same time, the extent of the relative movement may be controlled. The relative movement itself may provide for some delay in the forces that act against the foot of the wearer and thereby to joints and / or muscles of the wearer. Such delay may reduce peak forces that act against the foot of the wearer and thereby to joints and / or muscles of the wearer. This reduces the overall impacts to the wearer. At the same time, the forces due to friction also contribute to a "softer" feeling upon ground contact of the foot of the wearer. This entails that cushioning is improved and that the loads on the wearer are dampened. It may be the case that the shearing structure allows to reduce horizontal forces attributable to the relative movement. This may mean that the shearing structure is configured to dampen horizontal forces. In such an example, the shearing structure may be referred to as a horizontal force damping structure. However, the shearing structure is not limited to reduce horizontal forces. For instance, forces acting in any kind of direction, e.g., acting substantially parallel to a vertical axis, such as the upward direction and / or the downward direction, may also be dampened. As understood by the skilled person also the combination of force vectors may be dampened. Overall, the relative movement may contribute to a reduction of the kinetic energy. This increases the cushioning effect. This may result in a reduction of the joint loading to the wearer, which makes wearing the shoes for instance during running more comfortable.

[0017] Next to the above-mentioned sliding friction due to the relative movement, the relative movement may also provide for internal friction. The internal friction may be understood as friction within a material of the midsole comprising the upper midsole layer and the lower midsole layer. Without wishing to be bound by theory, it is believed that internal friction may be caused by tenacity or the like of the material of the midsole comprising the upper midsole layer and the lower midsole layer. For instance, the relative movement may allow for deformation of the upper midsole layer and / or the lower midsole layer. Such deformation may lead to internal friction. This may also contribute to a reduction of the kinetic energy, which increase the cushioning effect as described elsewhere herein.

[0018] The frictional forces and in particular the frictional forces due to the relative movement between the upper midsole layer and the lower midsole layer may lead to the generation of heat. This friction aids in reducing the kinetic energy along with the advantages associated therewith as mentioned elsewhere and in particular in the foregoing. This may be of importance for instance during downhill running. Nevertheless, this is also important in any other kind of athletic activity.

[0019] In most prior art solutions, high-performance foams are usually employed, which are provided with portions of weakness, such that a deformation may occur. However, these foams still provide a rather high energy return, which can negatively impact forces on the joints of the wearer. The inventors found a way to overcome these problems according to the sole for a shoe and in particularly attributable to the shearing structure as described herein.

[0020] The term "midsole" as used in the present disclosure may be referred to as a layer of material that may be located between an outsole of a shoe, e.g., the bottom part of the sole that contacts the ground, and an upper of a shoe, e.g., the part of the shoe that covers the top of a foot of a wearer.

[0021] The upper midsole layer and the lower midsole layer being at least partially "distinct from one another" as used herein may be understood such that the upper midsole layer and the lower midsole layer represent at least partially two distinct entities that may be separate, different, and / or distinguishable from each other. It may imply that there are at least partially differences in terms of characteristics, qualities, and / or functionalities that allow to distinguish the upper midsole layer and the lower midsole layer from one another. These differences may be noticeable to the skilled person. In one example, the upper midsole layer and the lower midsole layer may be unique to some extent. However, to the extent that the upper midsole layer and the lower midsole layer may be distinguishable in terms of their functionalities, it may nevertheless be possible that the upper midsole layer and the lower midsole layer may not always be able to be distinguished from one another from a mere visual inspection. Further, the upper midsole layer and the lower midsole layer being at least partially "distinct from one another" may not preclude that they are comprised of the same material and / or that they are attached to one another at least partially. Further, it is also not precluded that the upper midsole layer and the lower midsole layer are integrally formed as long as they may be distinguishable from one another. Moreover, since the upper midsole layer and the lower midsole layer are "at least partially" distinct from one another, this may comprise that they are partially attached to one another and / or at least partially integrally formed.

[0022] The term "shearing structure" as used herein may be understood such that a structure is provided that facilitates shearing. It is noted that the shearing structure may not be limited in its size to provide for the advances as described in here. Nevertheless, the shearing structure may be recognized as such a shearing structure by the skilled person without investigative effort needed. This is implied by the term "structure". For instance, the shearing structure may be understood to be of macroscopic size. The shearing structure may not be a mere impurity of a material, such as a foam, of the midsole and / or a mere microscopic gas inclusion. The latter examples may occur without intention and may not correspond to a shearing structure. It is understood that the shearing structure is provided specifically with the intention to allow for the relative movement of the upper midsole layer and the lower midsole layer in a substantial way. Further, the shearing structure may be recognizable as allowing for such a function. Such recognizing may be performed from a visual and / or functional perspective. For instance, the shearing structure may be visible and / or the shearing structure could be distinguished from other parts due to its function as described herein.

[0023] The term "shearing" as used herein may be understood such that two or more elements, parts, components, layers, or the like, for instance two contiguous parts of a body slide against one another. As understood in the context of the present disclosure, the two elements, parts, components, layers, or the like may be the upper midsole layer and the lower midsole layer. The term shearing may mean that the upper midsole layer and the lower midsole layer slide in opposite directions. Moreover, they may slide relatively to each other in a direction parallel to their plane of contact or intended contact, or to a plane in between of the two layers, in case the two layers are spaced apart from one another. They may slide in the same direction but to a different extent. Although it is possible that the two layers are contacting one another, it is well encompassed that there is a space in between while the two layers are sliding against one another. The space may be at least partially filled by the shearing structure. Shearing may be caused by an action or stress resulting from applied forces, such as forces due to the load of the wearer. The relative movement may occur under a pressure load on the sole. It is noted that shearing may take place in any kind of direction, preferably it takes place substantially parallel to a heel to toe axis of the sole.

[0024] The term "structure" as used herein may be understood such that it has a physical extension. For instance, it may be recognizable as a structure by the skilled person, and / or it may be touchable by the skilled person. The structure may be provided by any kind of means, for instance, mechanical elements, a space, a portion or a material of the upper midsole layer and / or the lower midsole layer, and / or the like.

[0025] The term "relative movement" as used herein may be understood such that during ordinary use of the sole for a shoe, such a movement may be recognizable by the skilled person without investigative effort. The relative movement is to be understood such that an intentional movement is provided. Thereby, it may be the case that relative movements on a microscopic level

may not be sufficient to be termed as having a relative movement within the meaning of the present disclosure. Further, since the upper midsole layer and the lower midsole layer are at least partially distinct from one another, the relative movement is recognized in that these layers may be sliding against one another. For instance, a distance, such as a distance in a medial and / or lateral direction is recognizable. The direction of this sliding is not limited to a particular one and all directions of space are encompassed in the present disclosure.

[0026] It is noted that the term "upper" of the expression "upper midsole layer" does not limit the term "midsole layer" itself. In particular, this does not mean that the "upper midsole layer" is necessarily arranged on an upper side of something. Same applies to the term "lower" of the expression "lower midsole layer". However, as detailed elsewhere herein, such an understanding that the upper midsole layer is arranged on an upper side of the lower midsole layer may be helpful to explain preferred embodiments of the first aspect of the present disclosure in greater detail.

[0027] The sole for a shoe described herein may be particularly useful in conjunction with and / or when applied to a sports shoe, such as a running shoe, in particular a long-distance running shoe, or the like. However, it should be noted that the sole could be used with any kind of article of footwear including, but not limited to football shoes, hiking boots, sneakers, basketball shoes, rugby shoes, baseball shoes, golf shoes, tennis shoes, cross-training shoes. Moreover, the sole may be used in conjunction with shoes for any kind of athletic activity.

[0028] The term "athletic activity" is to be understood such that it includes one or more and / or any combination of at least the following non-exhaustive list: aerobics, athletic exercises, running, hiking, climbing, group fitness classes, walking, cycling, yoga, soccer, tennis, football, basketball, doing a workout, volleyball, gymnastics, weightlifting, cross-training, baseball, softball, rugby, field hockey, wrestling, squash, track and field (such as sprinting, long jump, high jump), cross-country skiing, golfing, lacrosse, triathlon.

[0029] Further, it may be possible that the shearing structure providing for the benefits described herein are additionally or alternatively used for any kind of equipment used in athletic activities. That is, the shearing structure is not necessarily limited to the example of a sole for a shoe. It could be feasible that the concept of the shearing structure is transferred to any kind of activity or athletic activity in which stability, comfort, damping of forces, or generally any support and / or improved feeling to the wearer is required.

[0030] Nevertheless, it was found that the advantages of the shearing structure described herein are particularly pronounced when applied to a sole for a shoe, such as a shoe used during an athletic activity.

[0031] The term "wearer" as referred to herein may be any kind of human capable of wearing an article of footwear. The term "wearer" may be used synonymously to the terms "user", "athlete", "human being", "individual", "person" or the like.

Movement direction and location of structure

[0032] In a preferred embodiment of the sole for a shoe as described herein, the relative movement between the upper midsole layer and lower midsole layer is in a plane defined by a medial to lateral axis of the sole and a heel to toe axis of the sole, wherein the relative movement between the upper midsole layer and lower midsole layer is preferably substantially parallel to a heel to toe axis of the sole.

[0033] This may have the advantage that horizontal forces can be dampened by the shearing structure. This may be beneficial as the forces provided by the shearing structure are then not directly directed to a central part of the body of the wearer. Hence, this has the advantage that impacts on joints and / or muscles can be reduced.

[0034] It is noted that horizontal forces may occur during first contact of the sole with the ground and due to the relative movement of the upper midsole layer and the lower midsole layer.

[0035] When the relative movement between the upper midsole layer and lower midsole layer is substantially parallel to a heel to toe axis of the sole this may have the further advantage that a movement parallel to a medial to lateral axis of the sole is diminished and/or substantially zero. This aids in providing stability to the foot of the wearer. It is particularly advantageous that the shearing movement can provide for frictional forces leading to the generation of heat, which aids in reducing the kinetic energy. This may be in particular of importance for instance during downhill running. Nevertheless, this is also important in any other kind of athletic activity.

[0036] In a preferred embodiment of the sole for a shoe as described herein, the shearing structure is configured to allow the relative movement between the upper midsole layer and the lower midsole layer in at least one of a forefoot portion of the midsole, a midfoot portion of the midsole, a rearfoot portion of the midsole, a lateral portion of the midsole and a medial portion of the midsole, preferably in at least one of a forefoot portion of the midsole and a midfoot portion of the midsole, such as a lateral forefoot portion of the midsole, a medial forefoot portion of the midsole, a lateral midfoot portion of the midsole, and a medial midfoot portion of the midsole, most preferably in at least one of a lateral forefoot portion of the midsole and a lateral midfoot portion of the midsole.

[0037] This may have the advantage that damping of the forces may be particularly pronounced in the portions specified in this embodiment. It was found that while the prior art may focus on the rearfoot portion of the midsole to claim improvement of cushioning, the remainder of the portions of the midsole is often neglected or of less concern. According to the present disclosure, this disadvantage can be successfully counteracted. The advantages of the sole of the present disclosure may be

particularly pronounced in downhill running, since the gait cycle during such downhill running may differ from flat and / or uphill running. For instance, during downhill running, mostly the forefoot may make ground contact first. Thereby, providing the shearing structure in the forefoot portion and / or the midfoot portion may be particularly advantageous.

[0038] It was found that arranging the shearing structure such that relative movement between the upper midsole layer and the lower midsole layer is configured to be in a lateral forefoot portion contributes to further flexibility of the sole for a shoe in general. For instance, some of the remaining portions of the midsole may be equipped with further functional elements and / or properties in general. Other functional elements may be for instance the sole plate as described elsewhere herein. Thereby, all these functionalities may act together to provide a combined advantageous effect. In addition, manufacturing of the shearing structure in the lateral forefoot portion may be performed in a simplified manner.

[0039] However, as described in this embodiment, the shearing structure is not limited to be in the lateral forefoot portion. Rather, the shearing structure may be arranged in any other portion of the midsole. In one example, a plurality of shearing structures may be arranged in the midsole to provide for a combined advantageous effect that contributes to further damping forces to the body of the wearer.

[0040] In one example, it may be possible that when the shearing structure is configured to allow relative movement between the upper midsole layer and the lower midsole layer in any one of the portions specified in here, the shearing structure itself is also arranged in the respective portion.

[0041] In a preferred example, the relative movement means that the upper midsole layer moves further from the heel of the midsole in the direction of the toe of the midsole substantially parallel to the heel to toe axis compared to the lower midsole layer. In another example, the relative movement means that the lower midsole layer moves further from the heel of the midsole in the direction of the toe of the midsole substantially parallel to the heel to toe axis compared to the upper midsole layer.

Structure shaping and engagement

[0042] In a preferred embodiment of the sole for a shoe as described herein, the shearing structure comprises an upper shearing structure on the upper midsole layer and a lower shearing structure on the lower midsole layer, wherein the upper shearing structure and the lower shearing structure are facing one another, wherein the upper shearing structure and the lower shearing structure are preferably arranged in a forefoot portion of the midsole and / or a midfoot portion of the midsole, most preferably in a lateral forefoot portion of the midsole and / or a lateral midfoot portion of the midsole.

[0043] This may have the advantage that the functionality of the shearing structure may be at least partially separated into at least two structures, namely the upper shearing structure and the lower shearing structure. Nevertheless, as described elsewhere herein, the upper midsole layer and the lower midsole layer may only be partially distinct from one another. Hence, they may be attached to one another and / or integrally formed at least partially. Hence, the two shearing structures may increase flexibility. For instance, the upper midsole layer and the lower midsole layer may each be provided with a specifically designed structure during manufacturing, which, when assembled may allow the upper midsole layer and the lower midsole layer to reveal the advantages described in here.

[0044] The same as set forth elsewhere herein with respect to the term "structure" applies to the term "upper shearing structure" and the "lower shearing structure" as understood by the skilled person. That is, these terms may mean that the respective structures may have a physical extension. Further, they may be recognizable as a structure by the skilled person, and / or they may be touchable by the skilled person.

[0045] Although possible, the upper shearing structure and the lower shearing structure facing one another does not mean that the upper shearing structure and the lower shearing structure are contacting one another. Rather, this merely means that they are directed to one another. This may further contribute to the advantages as described elsewhere herein with respect to the damping effect.

[0046] The term "upper" of the expression "upper shearing structure" does not limit the term upper shearing structure itself. In particular, this does not mean that the "upper shearing structure" is arranged on an upper surface or a lower surface of the upper midsole or the like. Rather, the term "upper" in this context is merely used to indicate that the "upper shearing structure" is comprised by the upper midsole layer.

[0047] In a preferred embodiment of the sole for a shoe as described herein, the upper shearing structure and the lower shearing structure are at least partially engaged with one another.

[0048] To be "engaged" may be understood as to be accommodated and / or to be received.

[0049] This has the advantage that the upper shearing structure and the lower shearing structure may be easily assembled and may provide for a firm construction. Although possible, said firm construction may not necessarily need any separate means for attachment such as fasteners, adhesives, or the like. The arrangement may therefore be regarded as being at least partially self-supporting.

[0050] Due to such engagement, the upper shearing structure and the lower shearing structure may be allowed to interact with one another and / or to contact one another at least partially. Thereby, movements, such as shearing, may increase frictional forces between the upper shearing structure and the lower shearing struc-

ture, causing generation of heat and, in turn, reduction of the kinetic energy. It is noted that most of the prior art cushioning elements are limited to the principle of deformation of parts of the sole alone. This limitation is overcome by the shearing structure and in particular by way of the upper shearing structure and the lower shearing structure as proposed in here. In turn, the reduction of the kinetic energy may enable damping which could reduce joint loading to a wearer and thereby reduce muscle damage and fatigue.

[0051] In a preferred embodiment of the sole for a shoe as described herein, the upper shearing structure and the lower shearing structure are substantially shaped in correspondence to one another.

[0052] This contributes to the shearing movement between the upper shearing structure and the lower shearing structure. Moreover, engaging the upper shearing structure and the lower shearing structure at least partially with one another may thereby be simplified.

[0053] To be "substantially shaped in correspondence to one another" may mean that the upper shearing structure may have a protrusion or the like, which could engage into a recess of the lower shearing structure and / or vice versa. However, being shaped substantially in correspondence to one another may alternatively or additionally mean that the upper shearing structure and the lower shearing structure may have substantially the same surface area, the same shape to fit into one another, or a similar surface structure that allows engagement into one another.

[0054] In a preferred embodiment of the sole for a shoe as described herein, the upper shearing structure and the lower shearing structure are engaged with one another via a form-fit connection.

[0055] The "form-fit connection" may be understood such that the upper shearing structure and the lower shearing structure may be shaped or designed to fit into one another. This may create an improved engagement without the need for additional fasteners or adhesives. The engagement may rely on the geometry of the upper shearing structure and the lower shearing structure. Nevertheless, it is noted that the form-fit connection only refers to the shape of the upper shearing structure and the lower shearing structure. In particular, the form-fit connection may not be confused with a rigid connection. Rather, shearing movement of the upper midsole layer and the lower midsole layer is well encompassed by it as described elsewhere herein in greater detail.

[0056] Due to such form-fit connection, the upper shearing structure and the lower shearing structure can be easily assembled, which could significantly reduce labor and manufacturing costs.

[0057] The form-fit connection may be understood in one example as a one to one correspondence. It is noted that the form-fit connection may not preclude any deformation of the upper midsole layer and / or the lower midsole layer. Such a deformation may be particularly appreciated as mentioned elsewhere herein. Further, the form-fit connection may also not preclude any shearing movement of the upper midsole layer and / or the lower midsole layer. Such a shearing movement is particularly appreciated as mentioned elsewhere herein.

[0058] It is noted that, that the use of additional means for attachment of the upper shearing structure and the lower shearing structure such as fasteners, adhesives or the like may not necessarily be precluded merely by the engagement or the form-fitting arrangement. In one example, additional means for attachment of the upper shearing structure and the lower shearing structure such as fasteners, adhesives or the like are provided.

[0059] In a preferred embodiment of the sole for a shoe as described herein, the upper shearing structure is integrally formed with the upper midsole layer and the lower shearing structure is integrally formed with the lower midsole layer.

[0060] This may be understood in such a manner that the upper shearing structure and the upper midsole layer are formed as one unitary piece and that the lower shearing structure and the lower midsole layer are formed as one unitary piece. Thereby, the upper shearing structure and the upper midsole layer may not be separate pieces but may form one upper midsole layer and the lower shearing structure and the lower midsole layer may not be separate pieces but may form one lower midsole layer.

[0061] This can reduce manufacturing effort and costs, which is appreciated when the sole for a shoe is made for mass production.

Details of structure / protrusions

[0062] In a preferred embodiment of the sole for a shoe as described herein, the upper shearing structure comprises one or more upper protrusions and the lower shearing structure comprises one or more lower recesses, and / or wherein the lower shearing structure comprises one or more lower protrusions and the upper shearing structure comprises one or more upper recesses.

[0063] This may have the advantage that the upper shearing structure and the lower shearing structure can interact with one another. For instance, the one or more upper protrusions of the upper shearing structure may interact with the one or more lower recesses of the lower shearing structure. Likewise, the one or more lower protrusions of the lower shearing structure may interact with the one or more upper recesses of the upper shearing structure. This can aid in allowing a relative movement between the upper midsole layer and the lower midsole layer whilst said movement is controlled to a certain extent.

[0064] The one or more protrusions (the protrusions are sometimes described herein without the prefix of "upper" and / or "lower" for brevity only and the skilled person understands that the description may refer to both protrusions) as referred to herein may be understood as

something that extends from a surface or object. The term protrusion may be used to describe any part of an object or structure that juts out, sticks out, or extends beyond the surrounding surface or boundary. In one example, the protrusion may be a three-dimensional extension or projection that extends outward from a surface or object. The protrusion can maybe provided in various sizes. The size, shape, or the like of the protrusion may vary depending on the intended purpose and / or the desired outcome. Substantially all technically meaningful sizes and shapes may be encompassed in the present disclosure.

[0065] The protrusion as described in here may provide a structural benefit and / or may provide for more specific functionalities, in particular in the context of cushioning. In addition, the protrusion can contribute to the visual appearance, which could give the wearer an indication at which location a specific functionality is provided in the sole.

[0066] The one or more recesses (the recesses are sometimes described herein without the prefix of "upper" or "lower" for brevity only and the skilled person understands that the description may refer to both recesses) as referred to herein may be a hollow or indented area or space that is set back or carved into a surface, structure, object, or the like. The recess may be essentially the opposite of a protrusion. The recess may provide for various functionalities as described elsewhere in here in greater detail.

[0067] The term "upper" of the expression "upper protrusion" does not limit the term protrusion itself. In particular, this does not mean that the "upper protrusion" is arranged on an upper surface or a lower surface or the like. Rather, the term "upper" in this context is merely used to indicate that the "upper protrusion" is comprised by the upper shearing structure.

[0068] Likewise, the term "lower" of the expression "lower recess" does not limit the term recess itself. In particular, this does not mean that the "lower recess" is arranged on a lower surface or an upper surface or the like. Rather, the term "lower" in this context is merely used to indicate that the "lower recess" is comprised by the lower shearing structure.

[0069] The term "lower" of the expression "lower protrusion" does not limit the term protrusion itself. Rather, the term "lower" in this context is merely used to indicate that the "lower protrusion" is comprised by the lower shearing structure.

[0070] Likewise, the term "upper" of the expression "upper recess" does not limit the term recess itself. In particular, this does not mean that the "upper recess" is arranged on an upper surface or a lower surface or the like. Rather, the term "upper" in this context is merely used to indicate that the "upper recess" is comprised by the upper shearing structure.

[0071] In a preferred embodiment of the sole for a shoe as described herein, the one or more upper protrusions are at least partially accommodated in the one or more lower recesses, and / or wherein the one or more lower protrusions are at least partially accommodated in the one or more upper recesses.

[0072] This may have the advantage that the protrusions and recesses facilitate the control of the movement. This can aid in reducing loads occurring during ground contact of the sole. This may be the case up to a certain extent. As noted elsewhere herein, a defined stop may be provided by way of the protrusions and recesses along the heel to toe axis of the sole. In such a defined stop state, shearing movement may be prevented. Thereby, impacts on joints and / or muscles of the wearer can be reduced overall and at the same time, safety is increased, as there is a defined stop. Thereby, wearing shoes comprising these soles becomes more comfortable and safer, which is particularly noticeable during an athletic activity, such as during running.

[0073] The term to be "accommodated" may mean that the respective protrusions and recesses are such that they fit or match the shape and / or space of the respective other ones.

[0074] In a preferred embodiment of the sole for a shoe as described herein, the one or more upper protrusions and / or the one or more lower protrusions are spaced apart from one another as seen in a horizontal plane of the sole, preferably as seen along a heel to toe axis of the sole.

[0075] This may have the advantage that a relative movement of the upper midsole layer and the lower midsole layer can be enhanced. For instance, the space so provided between the protrusions may be empty or filled, which allows more flexibility in controlling the relative movement. Thereby, according to this embodiment, a reduction of kinetic energy can be controlled to a greater extent. Thereby, a reduction of the joint loading and an improvement of the cushioning to the wearer can be achieved.

[0076] It is understood that when reference is made to "the one or more upper protrusions and / or the one or more lower protrusions being spaced apart from one another", this means that the one or more upper protrusions are spaced apart from one another and / or this means that the one or more lower protrusions are spaced apart from one another. It may not mean that one or more upper protrusions are spaced apart from the one or more lower protrusions. However, it is noted that in some cases, the latter may still be encompassed by the present disclosure.

[0077] Being spaced apart means that a distance from the two respective elements may pertain. In one example, the distance may be recognizable by the skilled person without any specific equipment being necessary.

[0078] The horizontal plane as referred to herein may be substantially perpendicular to a vertical axis. The horizontal plane may be a plane defined by a heel to toe axis and a medial to lateral axis of the sole.

[0079] In a preferred embodiment of the sole for a shoe as described herein, the one or more upper protrusions

and / or the one or more lower protrusions are spaced apart from one another as seen in a horizontal plane of the sole, preferably as seen along a heel to toe axis of the sole, by at least 1 cm, preferably at least 1.5 cm, more preferably at least 2 cm, even more preferably at least 2.5 cm, most more preferably at least 3 cm, and / or by at most 8 cm, preferably at most 6 cm, more preferably at most 5 cm, even more preferably at most 4 cm, further more preferably at most 3.5 cm, most preferably of at most 3 cm.

[0080] With the spacing of the one or more upper protrusions and / or the one or more lower protrusions as specified in this embodiment, an optimal balance can be struck between two different and / or conflicting requirements.

[0081] On the one side, sufficient relative movement of the upper midsole layer and the lower midsole layer should be provided, which can lead to a reduction of kinetic energy and, thereby, to a reduced joint loading and improved cushioning to the wearer. For this, a greater spacing may be beneficial. On the other side, it should be ensured that the sole still provides for sufficient stability such that the wearer can perform his or her activity in a substantially safe manner. For this, a smaller spacing would be beneficial.

[0082] Thus, without wishing to be bound by theory, it is believed that an optimal balance between these conflicting requirements can be struck according to the values as specified in here.

[0083] In a preferred embodiment of the sole for a shoe as described herein, the one or more upper protrusions and the one or more upper recesses are arranged in an alternating manner, preferably as seen along a heel to toe axis of the sole.

[0084] This may have the advantage that a simplified pattern can be established. In addition, assembling the upper midsole layer and the lower midsole layer may be improved. Arranging the protrusions and recesses in an alternating manner along the heel to toe axis may be particularly advantageous to dampen forces along the medial to lateral axis of the sole.

[0085] The alternating manner may be understood such that an upper protrusion is followed by an upper recess, followed by an upper protrusion and so forth.

[0086] In a preferred embodiment of the sole for a shoe as described herein, the one or more upper protrusions and / or the one or more lower protrusions have an elongated shape, preferably having a longitudinal axis that is substantially parallel with a medial to lateral axis of the sole.

[0087] The elongated shape may have the advantage that the firmness and / or the stability of the shearing structure can be influenced and / or adjusted according to one's needs. In addition, it allows for flexibility to impart further functionalities to the shearing structure.

[0088] The term "elongated" means that there may be a dimension along one axis of the protrusion, which may be larger than one and preferably than both dimensions along the remaining axes, the remaining axes being substantially perpendicular to said one axis. It is understood that when dimensions are described herein, manufacturing tolerances usually must be taken into consideration. Thus, the dimensions described herein may vary slightly.

[0089] In a preferred embodiment of the sole for a shoe as described herein, the one or more upper protrusions and / or the one or more lower protrusions have a shape as seen in a horizontal plane of the sole comprising one or more of a line segment defined by a mathematical function, in particular a periodic mathematical function, such as a sine wave, a line segment of a zigzag, a line segment of a sawtooth.

[0090] This may have the advantage that the relative movement of the upper midsole layer and the lower midsole layer can be enhanced and / or controlled to a greater extent. Further, having an angled shape of the protrusions allows for some interlocking of one or more upper protrusions with respective one or more lower recess and / or of one or more lower protrusions with respective one or more upper recesses. Said interlocking may improve that the upper midsole layer and the lower midsole layer do not substantially move relative to one another along the medial to lateral axis of the sole. This may enhance in providing sufficient stability to the wearer during running. At the same time, sufficient shearing movement along the heel to toe axis is allowed, which reduces the mechanical load to the wearer. The angled shape of the protrusions may also allow to generate a softer stop, e.g., a softer defined stop. This may be better compared to a quite harsh and / or immediate stop.

[0091] As the skilled person will understand, the shape as seen in the horizontal plane of the sole may mean in this context, that even if the protrusion was not located in said plane, it would be represented by a projection onto the two-dimensional horizontal plane.

[0092] It is understood that the shearing forces that occur can affect the overall performance of the sole for a shoe. Excessive shearing can lead to instability and reduced control during running, impacting the gait cycle and potentially leading to discomfort or injury. Hence, this embodiment has the advantage that the extent of the relative movement is somewhat controlled. For instance, the relative movement may be at least partially limited.

[0093] It is noted that the shape may comprise one or more of the specified line segments in here. This means that any combination of the specified line segments may be arranged consecutively, for instance in an arbitrary manner to provide for the shape.

[0094] It is particularly preferred when the shape may be composed of a zigzag line or a sawtooth line. In this manner, an improved movement control along the heel to toe axis for the upper midsole layer and the lower midsole layer can be provided. This may improve guidance of the upper midsole layer and the lower midsole layer. This may lead to a softer stop, e.g., a softer defined stop, as compared to a quite harsh and / or immediate stop. Such

a softer stop was found to be advantageous to dampen the impacts to the body of the wearer.

[0095] In a preferred embodiment of the sole for a shoe as described herein, the one or more upper protrusions and / or the one or more lower protrusions comprise one or more side surfaces, the normal of which being substantially parallel to a horizontal plane of the sole, the side surfaces being angled with respect to a medial to lateral axis of the sole, preferably having an angle of at least 2°, preferably at least 5°, more preferably at least 10°, even more preferably at least 15°, even more preferably at least 20°, further more preferably at least 25°, further more preferably at least 30°, and / or of at most 85°, preferably at most 80°, more preferably at most 60°, even more preferably at most 55°, even more preferably at most 50°, further more preferably at most 45°, further more preferably at most 40°.

[0096] On the one side, an increase of the angle may yield more resistance of the respective protrusions that are substantially interlocked into one another. For instance, an angle of 90° means that the side surfaces are substantially perpendicular to a medial to lateral axis of the sole, i.e., substantially parallel to a heel to toe axis of the sole. Hence, if the angle is too large, a desired relative movement may be limited too much. Thus, a smaller value of the angle would be beneficial.

[0097] On the other side, it should be ensured that the angle is not too small, since the resistance of the respective protrusions that are substantially interlocked into one another could otherwise be too little. This may lead to an unsafe feeling during running, as the relative movement may not be limited to a sufficient amount. Thus, a greater value of the angle would be beneficial.

[0098] Against this background, without wishing to be bound by theory, it is believed that an optimal balance between these conflicting requirements can be struck according to the values as specified in here.

[0099] In a preferred embodiment of the sole for a shoe as described herein, the one or more upper protrusions and / or the one or more lower protrusions have a maximum height perpendicular to a horizontal plane of the sole of at least 2 mm, preferably at least 3 mm, more preferably at least 5 mm, even more preferably at least 8 mm, most preferably at least 10 mm, and / or of at most 20 mm, preferably at most 18 mm, more preferably at most 16 mm, even more preferably at most 14 mm, most preferably at most 12 mm.

[0100] On the one side, the one or more upper protrusions and / or the one or more lower protrusions should have a sufficient height such that they may properly engage into corresponding one or more recesses. As understood, this may aid in providing a deformation of the upper protrusions and / or the lower protrusions, as the material is somewhat weakened, contributing to material deformation. Thus, this may contribute to a reduction of kinetic energy and, thereby, to a reduced joint loading and improved cushioning to the wearer. For this, a greater height may be beneficial. On the other side, the height of the one or more upper protrusions and / or the one or more lower protrusions should not be too large, since the overall thickness of the midsole may unnecessarily increase. In addition, a weight of the sole would be increased due to protrusions having rather large height. For this, a smaller height would be beneficial.

[0101] Thus, without wishing to be bound by theory, it is believed that an optimal balance between these conflicting requirements can be struck according to the values as specified in here.

[0102] The maximum height may be understood as an average height based on the eight of substantially all protrusions that are provided. However, in one example, the maximum height may mean that it is the maximum height of one protrusion.

[0103] It is noted that a distance may be provided between an upper protrusion and a respective lower recess and / or between a lower protrusion and a respective upper recess in a plane defined by a medial to lateral axis of the sole and a heel to toe axis of the sole. This distance may aid in providing frictional forces, when a respective protrusion is moved in order to bridge said distance. This may aid in converting kinetic energy to heat in order to reduce impacts on joints of the wearer.

Sole plate

[0104] In a preferred embodiment of the sole for a shoe as described herein, the sole further comprises a sole plate provided between the upper midsole layer and the lower midsole layer configured to control the relative movement between the upper midsole layer and the lower midsole layer.

[0105] This may have the advantage that the upper midsole layer and the lower midsole layer are provided with further functionality, including but not limited to an increased stiffening. Further, the sole plate may allow to finetune the relative movement of the upper midsole layer and the lower midsole layer. The term "to control" the relative movement may mean that the relative movement is hindered and / or promoted. As understood, such controlling may depend on the desired outcome and / or the use case of the sole for a shoe.

[0106] The term sole plate may refer to a flat plate or surface that is used for a specific purpose. The sole plate may provide for stability and support to the foot of the wearer.

[0107] In a preferred embodiment of the sole for a shoe as described herein, the sole plate comprises projections and / or indentations that are engaged with corresponding indentations and / or projections provided in the lower midsole layer and / or the upper midsole layer.

[0108] This further contributes to the advantages mentioned in the foregoing embodiment. In particular, the control of the relative movement may be improved due to the projections and / or indentations.

[0109] In a preferred embodiment of the sole for a shoe as described herein, the projections of the sole plate are

at least partially hollow and / or at least partially filled with foam.

[0110] This may have the advantage that the projections can be equipped with a different functionality than the remainder of the sole plate. Thereby, the overall function of the sole plate can be targeted to a more specific use case. The hollow and / or at least partially filled projections have the additional function of a stiffer arrangement. This can contribute to the stability of the sole for a shoe. This may be important in order to compensate the relative movement due to the shearing structure at least partially. Hence, stability and cushioning may be provided at the same time.

[0111] In a preferred embodiment of the sole for a shoe as described herein, the sole plate is elongated and arranged along a heel to toe axis, wherein the indentations and / or projections provided in the lower midsole layer and / or the upper midsole layer are also elongated and arranged along a heel to toe axis of the sole.

[0112] This may have the advantage that the relative movement of the upper midsole layer and the lower midsole layer may be controlled to a greater extent. For instance, the elongated shape of the indentations and / or projections facilitate that forces substantially parallel to a medial to lateral axis may be absorbed to a greater extent. This does not mean that relative movement of the upper midsole layer and the lower midsole layer is prevented. That is, because such a relative movement substantially parallel to the heel to toe axis of the sole is desired according to the sole for a shoe as proposed in here.

[0113] The term "elongated" as referred to in this embodiment may be understood to be similar as described elsewhere herein.

[0114] In a preferred embodiment of the sole for a shoe as described herein, the indentations and / or projections of the sole plate have a substantially half circular profile or circular segment profile, preferably as seen along a heel to toe axis.

[0115] This may have the advantage that controlling of the relative movement of the upper midsole layer and the lower midsole layer can be increased. The profile as specified in here allows a good compromise between relatively high restriction in movement along a lateral and medial side, while at the same time, the rounded shape contributes to sliding along a heel to toe axis of the sole. Thus, the profile as described in this embodiment creates more flexibility and contributes to an improved sole for a shoe.

[0116] In one example, the profile has substantially a similar shape along its overall length as seen in the heel to toe axis. In another example, the shape of the profile may vary along its overall length along the heel to toe axis.

[0117] As understood, the half circular profile or the circular segment profile may not be a perfect half circular profile or circular segment profile. Rather, manufacturing tolerances may lead to minor deviations of such perfect profiles.

[0118] In a preferred embodiment of the sole for a shoe as described herein, the sole plate comprises a stopping element arranged obliquely with respect to the projections and / or indentations of the sole plate, the stopping element preferably being arranged in a toe portion of a forefoot portion of the midsole.

[0119] This may have the advantage that the sole plate can be tailored to fit into the midsole in a more precise manner. Further, the position of the sole plate can be substantially maintained during usage of a shoe comprising such a sole. The oblique arrangement of the stopping element with respect to the projections and / or indentations of the sole plate allows support in two substantially perpendicular directions. This may ensure for instance that the sole plate does not substantially move relative to another part of the midsole, although such relative movement cannot be precluded according to the sole for a shoe as proposed in here.

[0120] The stopping element may be implemented by various means. For instance, a mechanical stop may be provided. In such an example, the stopping element may have a physical extension and may be recognized as such an element. In this example, the physical extension of the stopping element may provide for some engagement with another part of the midsole, for instance with the upper midsole layer and / or the lower midsole layer. Said engagement may comprise a form-fit connection as described elsewhere herein in greater detail. In other examples, the stopping element may be provided by fasteners, adhesives or the like alone or in combination with a part having a physical extension.

[0121] In a preferred embodiment of the sole for a shoe as described herein, the sole plate extends along the complete length of the shearing structure as seen in a heel to toe axis of the sole.

[0122] This may have the advantage that the effect of the sole plate in terms of stiffening the sole for a shoe may be enhanced. In particular, since the shearing structure provides for a relative movement of the upper midsole layer and the lower midsole layer as described elsewhere herein, this portion of the midsole may be perceived to be "softer" for the wearer compared to other portions of the midsole. Thereby, when the sole plate extends along the complete length of the shearing structure, the softness may be partially compensated, and a good compromise can be found. In particular, the shearing structure is still able to provide for frictional forces enabling the sole for a shoe to reduce kinetic energy and, thereby, to reduce joint loading to the body of the wearer. Nevertheless, the sole may still provide for sufficient stability to the wearer and / or sufficient energy return in some cases due to the extension of the sole plate as described in this embodiment.

[0123] In one example, the sole plate may extend to at least 10%, preferably at least 20%, more preferably at least 30%, even more preferably at least 40%, even more preferably at least 50%, even more preferably at least 60%, even more preferably at least 70%, even more

preferably at least 80%, even more preferably at least 90% of the overall length of the sole along the heel to toe axis of the sole.

[0124] For instance, the sole plate may start in a midfoot portion of the sole and may extend to the toe portion of the sole.

Structure hollow space / filled

[0125] In a preferred embodiment of the sole for a shoe as described herein, the shearing structure comprises a hollow space, preferably being free from the upper midsole layer and / or the lower midsole layer.

[0126] The hollow space may have the advantage to allow for a greater relative movement between the upper midsole layer and the lower midsole layer. This may lead to an improved cushioning and to a reduced joint loading. Without wishing to be bound by theory, it is believed that the hollow space may enable improved internal and / or solid body friction, which may reduce the kinetic energy upon impact of the sole with the ground for instance. This enhances the cushioning effect. For example, shearing structure may be designed such that at least a portion of it can deform, thereby at least partially evading into the hollow space. As a result of which, surfaces of the shearing structure may contact one another providing for solid body friction. In addition, due to the deformation into the hollow space, internal friction may provide an additional benefit in reducing the kinetic energy and increasing the cushioning effect.

[0127] The term "hollow space" as used in the present disclosure may be referred to as a three-dimensional volume. In one example, the hollow space may be empty, e.g., there may be no parts, components, elements, or the like arranged in the hollow space. Being empty may encompass that gases such as air may be arranged in the hollow space. Alternatively or additionally, the hollow space may be filled at least partially with one or more parts, components, elements, or the like (for instance with a part of the midsole). In one example, the hollow space as referred to herein is understood as a macroscopic space, i.e., a space that could be easily recognized as such a space by the skilled person without the need for detailed investigations.

[0128] In one example, the hollow space may be a cavity or the like. In one example, the hollow space may comprise a plurality of interconnected sub hollow spaces that form the hollow space when taken in their combination. In one example, the hollow space may comprise a plurality of sub hollow spaces, wherein not all of the sub hollow spaces are connected with one another. Said plurality of sub hollow spaces may form the hollow space when taken in their combination. The hollow space may be at least partially free to the environment in one example.

[0129] In a preferred embodiment of the sole for a shoe as described herein, the shearing structure comprises a solid material, such as foam material.

[0130] The solid material may have the advantage that friction of corresponding surfaces and or internal friction, i.e., friction within the material itself may be provided. This may lead to a reduction of the kinetic energy, which increase the cushioning effect. This may result in a reduction of the joint loading to the wearer, which renders wearing the shoes for instance during running more comfortable.

[0131] As described elsewhere in the present disclosure, the shearing structure may comprise a hollow space. However, this does not preclude that the shearing structure comprises a solid material. In one example, both are present, i.e., the shearing structure comprises a hollow space and a solid material.

Visibility

[0132] In a preferred embodiment of the sole for a shoe as described herein, the shearing structure is at least partially visible as seen from outside, preferably from a lateral side of the midsole and / or a medial side of the midsole, more preferably from a lateral forefoot portion of the midsole and / or a medial forefoot portion of the midsole.

[0133] This may have the advantage that the outer appearance of the shearing structure could be adjusted to indicate to the wearer that the part of the sole that is visible, i.e., the shearing structure, has a certain functionality. Thereby, without wishing to be bound by theory, it is believed that the wearer could adapt his or her performance and / or behavior due to the visibility. For instance, the wearer may try to act, e.g., to run such that the shearing structure is not particularly exposed to external impacts that may cause damage thereof. Further, such a visibility may influence the wearer's performance, confidence, and / or motivation in engaging an athletic activity in the first instance.

[0134] In addition, the shearing structure being at least partially visible as seen from the outside may have the advantage that a state of the shearing structure, such as its solidity, firmness, integrity, load condition, damage, or the like may be assessed by a person.

[0135] The shearing structure being at least partially visible may be understood such that during ordinary use of the sole for a shoe, a human may recognize the shearing structure without significant investigation of the sole being necessary. However, it may be the case that in a fully assembled condition of the sole in the shoe, the shearing structure may not be visible or merely a part thereof may be visible as described elsewhere herein.

[0136] In a preferred embodiment of the sole for a shoe as described herein, the shearing structure has a sawtooth shape as seen from outside, preferably from a lateral side of the midsole and / or a medial side of the midsole, more preferably from a lateral forefoot portion of the midsole and / or a medial forefoot portion of the midsole.

[0137] At least the same advantages as mentioned in

the foregoing embodiment relating to the visibility of the shearing structure apply to the sawtooth shape as seen from outside of this embodiment as well.

[0138] It is noted that in some examples, when the shoe comprising the sole is assembled, the shearing structure may not be fully visible from the outside. In one example, further materials and / or elements may at least partially cover the shearing structure as seen from the outside. Thereby, in some instance, the term "seen from outside" may mean from outside the sole, when the shoe may not be fully assembled and / or manufactured. Nevertheless, it may well be the case that the shearing structure is almost fully visible from outside, even when the shoe is fully assembled and / or manufactured. As understood, the shearing structure may have an extension within the midsole, which would be covered by material and could therefore not be seen from the outside.

Materials

[0139] In a preferred embodiment of the sole for a shoe as described herein, the upper midsole layer comprises a first material and the lower midsole layer comprises a second material, wherein the first material is different than the second material, or wherein the first material is substantially the same as the second material.

[0140] This has the advantage that the upper midsole layer and the lower midsole layer can be equipped with different functionalities specifically tailored to a desired outcome. This may contribute to enhanced cushioning to the foot of the wearer. For instance, the upper midsole layer may be provided with a material specifically adapted to provide more cushioning to the foot of the wearer, as it may be in closer contact with the foot of the wearer. Alternatively or additionally, the other way around is also possible and not excluded by the present disclosure. For instance, the lower midsole layer may be provided with a material specifically adapted to provide more cushioning to the foot of the wearer.

[0141] The first material being different than the second material may have the particular advantage that different degrees of friction may be provided. This may include different degrees of internal friction and / or different degrees of solid body friction (static friction, rolling friction and / or dynamic friction). For instance, different materials revealing different frictional coefficients may be provided. Alternatively, or additionally, a surface roughness of the upper midsole layer and / or the lower midsole layer may be different. Overall, this allows to finetune the relative movement to dampen forces acting on the foot of a wearer. This can lead to a reduction of the kinetic energy upon impact of the sole with the ground for instance. This may lead to a reduction of the joint loading and to a reduction of the impacts to muscles as described elsewhere herein.

[0142] As an example, the first material may be lighter or heavier compared to the second material. As an example, the first material may have substantially the same weight as the second material.

[0143] The first material being substantially the same as the second material may have the advantage of improving the manufacturing process thereof. In addition, this could have the advantage that substantially the same material properties are provided in the lower midsole layer and the upper midsole layer. In some cases, this may be desired to have a substantially consistent performance and / or substantially consistent properties throughout the midsole. As understood, impurities of the first material and the second material may not be ruled out by this. That is, minor deviations in the composition of the first material and the second material may pertain although they may still be regarded as being substantially the same as understood by the skilled person.

[0144] In a preferred embodiment of the sole for a shoe as described herein, the midsole, in particular the upper midsole layer and / or the lower midsole layer, comprises or consists of a particle foam material, in particular a particle foam material comprising particles of expanded thermoplastic polyurethane, eTPU, particles of expanded polyamide, ePA, particles of expanded polyether-block-amide, ePEBA, and / or particles of expanded thermoplastic polyester ether elastomer, eTPEE.

[0145] This has the advantage that the materials are relatively easy to procure, cost-effective, and widely accepted in the sector of soles for shoes. Particle foams are particularly useful to provide for cushioning and energy return effect, since such materials may have good elastic and cushioning properties. Moreover, depending on the desired degree of cushioning, support, stability and / or solidity, a softer or harder material may be used. This allows to fine-tune the response of the midsole, in particular the upper midsole layer and the lower midsole layer, under a pressure load on the sole, e.g., from the ground. It may be possible that the choice of the material for the midsole, in particular the upper midsole layer and the lower midsole layer, is subject to the material of the upper and / or of the outsole of the shoe. This may have an advantage with respect to attachment of the respective parts.

[0146] Polyurethane foam may be a versatile material that offers several advantages due to its capability in providing comfort, cushioning, insulation and because it is relatively lightweight. Expanded thermoplastic polyurethane (eTPU) particles provides excellent elastic and cushioning properties. Thus, external shocks that arise, for example, when the sole hits the ground may be cushioned such that a pleasant wearing comfort is achieved.

[0147] Polyamide foam may also be known as nylon foam. It is a type of foam material made from polyamide polymers. Polyamide foam is lightweight, allows for good cushioning and comfort, can have a high durability, exhibits improved chemical resistance, is customizable in its composition and may be adjusted such that it has a

relatively low water absorption. This makes it suitable in applications where moisture resistance may be important. This could be advantageous for various athletic activities.

[0148] Further examples of particle foams may comprise expanded polypropylene (ePP). The use of particle foam may greatly facilitate manufacture of soles comprising such particles. That may be the case, because no special arrangement of the particles, for example, within a mold, is necessary and the particles may be blown or swept into the mold by a stream of air, steam, liquid, liquid-like powder materials, or the like. The particles may be easily subjected to further processing steps, like a pressure and / or steaming process, or fusion by melting the particle surfaces, under which they bond together without the need for further adhesives or the like.

[0149] In a preferred embodiment of the sole for a shoe as described herein, the midsole, in particular the upper midsole layer and / or the lower midsole layer, comprises or consists of a homogeneous foam material.

[0150] Such a homogeneous foam may be referred to as polymer foams, plastic foams. Such a homogeneous foam may be produced by injection molding or compression molding, for example. Homogeneous foams typically do not have a recognizable granular structure, i.e., they substantially do not have any identifiable particles within the finished foam.

Fixedly attached / outsole

[0151] In a preferred embodiment of the sole for a shoe as described herein, a portion of the upper midsole layer and a portion of the lower midsole layer are fixedly attached to one another.

[0152] This may have the advantage that the stability of the sole can be increased. When a portion of the upper midsole layer and a portion of the lower midsole layer are fixedly attached to one another, this has the advantage that larger frictional forces can be absorbed by the sole. In particular, when frictional forces due to the relative movement increase, it may be beneficial to provide for some attachment of a portion of the upper midsole layer and a portion of the lower midsole layer. This may ensure that these layers can be held together at least to some extent. In one example, a maximum allowable frictional force due to the relative movement may pertain, beyond which the stability of the sole may be impaired. It is believed that the maximum allowable frictional force may be increased at least partially by way of the attachment described in here.

[0153] It is noted that the attachment is advantageous, since otherwise the upper midsole layer and the lower midsole layer may likely fall apart, due to the relative movement by way of the shearing structure. That is, the upper midsole layer and the lower midsole layer should be fixedly attached to one another at least to such an extent that stability of the midsole can be ensured.

[0154] In a preferred embodiment of the sole for a shoe as described herein, the sole further comprises an outsole arranged below the midsole, preferably below the lower midsole layer.

[0155] The outsole may be the bottom portion of the sole that comes at least partially into direct contact with the ground. This means that not the overall outsole must necessarily contact the ground, although this may often be the case and is not precluded. The outsole may offer several advantages that contribute to the overall performance, comfort, grip, durability, stability, and support, water, and weather resistance of the sole.

Shoe

[0156] In a further aspect of the present disclosure, the objects are solved by a shoe, in particular a sports shoe, such as a running shoe, the shoe comprising: a sole according to any one of the embodiments described in here; and an upper attached to the sole.

[0157] It goes without saying that the technical properties shown or described for the sole, the advantages and the improvements over the state of the art are likewise applicable to the shoe, in particular the sports shoe. Same applies vice versa.

[0158] The upper may be attached to the sole by any kind of suitable means of attachment. As understood by the skilled person, attaching the upper of a shoe to the sole may involve various methods and techniques depending on the type of shoe, the materials used, and /or the desired level of durability and robustness of the upper.

[0159] In a preferred embodiment of the shoe, the shoe is one of a running shoe, a shoe used during workout, a shoe used during track and field, or the like. The mentioned advantages of the shoe may be particularly pronounced when the shoe is used during down hilling or the like, e.g., conditions under which the joints and muscles of the body of the wearer are usually exposed to high impacts.

Integrally formed upper midsole layer and lower midsole layer

[0160] In a second aspect of the present disclosure, the objects are solved by a sole for a shoe, in particular for a sports shoe, such as a running shoe, the sole comprising: a midsole comprising an upper midsole layer and a lower midsole layer, the upper midsole layer and the lower midsole layer being integrally formed; and a shearing structure, arranged in a midfoot portion of the midsole and / or a forefoot portion of the midsole; wherein the shearing structure is configured to allow a relative movement between the upper midsole layer and the lower midsole layer.

[0161] The term to be "integrally formed" may be understood as forming the upper midsole layer and the lower midsole layer as one unitary piece. This may mean that they are formed as a monolithic piece as described elsewhere herein. This may offer several advantages in various contexts as described elsewhere herein, e.g.,

improved strength and durability, simpler and easier manufacturing and / or assembling, cost savings, reduction of the overall weight of the resulting structure and / or product, improved performance as wearing, vibration, noise associated with separate moving parts, or the like may be reduced. Further advantages are the reduction of material costs, the reduction of labor costs, and / or the reduction of assembly time, the provision of a simplified construction leading to a more sustainable and eco-friendly structure and / or product.

[0162] In a preferred embodiment of the sole for a shoe as described in the second aspect, the sole for a shoe of the second aspect is the sole for a shoe of any one of the preceding embodiments relating to the first aspect described herein.

[0163] Thereby, any one or more of the embodiments, features, advantages, examples or the like as described herein with reference to the first aspect may be combined with the second aspect as described herein and vice versa.

[0164] In particular, it goes without saying that the technical properties shown or described for the sole for a shoe of the first aspect, the advantages and the improvements over the state of the art are likewise applicable to the sole for a shoe of the second aspect and vice versa.

Method

[0165] In a third aspect of the present disclosure, the objects are solved by a method for manufacturing a sole for a shoe, in particular for a sports shoe, such as a running shoe, preferably a shoe according to any one of the embodiments as described in here, the method comprising: providing a midsole comprising an upper midsole layer and a lower midsole layer, the upper midsole layer and the lower midsole layer being at least partially distinct from one another; providing a shearing structure, arranged in the midsole; wherein the shearing structure is configured to allow a relative movement between the upper midsole layer and the lower midsole layer.

[0166] It is understood that any one or more of the embodiments, features, advantages, examples or the like as described herein with reference to the remaining aspects herein may be combined with the third aspect as described herein and vice versa. In particular, it goes without saying that the technical properties shown or described for the sole for a shoe of the first aspect and the second aspect, the advantages and the improvements over the state of the art are likewise applicable to the method of the third aspect and vice versa.

[0167] It is noted that the term "substantially" as used herein may be used to include minor tolerances and / or variations. Hence, any values or arrangements described by using this term may slightly deviate from the described values or arrangements.

4. Brief description of the figures

[0168] In the following, the invention will be described in more detail with reference to the following figures:

Fig. 1: shows an upper midsole layer of a sole for a shoe, in particular for a sports shoe, according to an embodiment of the present disclosure.

Fig. 2: shows a lower midsole layer of a sole for a shoe, in particular for a sports shoe, according to an embodiment of the present disclosure.

Fig. 3: shows the embodiments of Fig. 1 and Fig. 2 in an assembled condition, according to an embodiment of the present disclosure.

Fig. 4: shows detailed views of Fig. 1 and Fig. 2.

Fig. 5: shows a sole plate for a sole for a shoe, in particular for a sports shoe, according to an embodiment of the present disclosure from two different sides.

Fig. 6: shows an upper midsole layer and a lower midsole layer of a sole for a shoe, in particular for a sports shoe, and a sole plate for a sole for a shoe according to an embodiment of the present disclosure.

Fig. 7: shows a shoe, in particular a sports shoe, comprising a sole and a sole plate according to an embodiment of the present disclosure.

Fig. 7a: shows the embodiments of Fig. 7 form the medial side.

5. Detailed description of the preferred embodiments

[0169] In the following only some possible embodiments of the invention are described in detail. However, the present invention is not limited to these, and a multitude of other embodiments are applicable without departing from the scope of the invention. The presented embodiments can be modified in several ways and combined with each other whenever compatible and certain features may be omitted in so far as they appear dispensable. In particular, the disclosed embodiments may be modified by combining certain features of one embodiment with one or more features of another embodiment.

[0170] It is to be understood that not all features of the described aspects / embodiments must be present for realizing the technical advantages provided by the present disclosure, which is defined by the subject-matter of the claims. The disclosed aspects / embodiments may be modified by combining certain features of one aspect / embodiment with one or more features of another aspect

/ embodiment. Specifically, the skilled person will understand that features, and / or functional elements of one aspect / embodiment can be combined with technically compatible features, and / or functional elements of any other aspect / embodiment of the present disclosure given that the resulting combination falls within the definition of the present disclosure.

[0171] While the embodiments below are described primarily with reference to a sole for a shoe, in particular for a sports shoe, the skilled person will recognize that the disclosure according to the invention can equally be applied in a plurality of different technical fields and / or use cases.

[0172] Throughout the present figures and specification, the same reference numerals refer to the same elements. For the sake of clarity and conciseness, certain aspects of components or steps of certain embodiments are presented without undue detail where such detail would be apparent to those skilled in the art in light of the teachings herein and / or where such detail would obfuscate an understanding of more pertinent aspects of the embodiments.

[0173] As understood by the skilled person and / or in order to avoid redundancies, reference is also made to the explanations in the preceding sections, which also apply to the following detailed description. Further, not all features, parts, elements, aspects, components and / or steps are expressly indicated by reference signs for the sake of brevity and clarity. This particularly applies, where the skilled person recognizes that such features, parts, elements, aspects, components and / or steps are present in a plurality.

Definitions

[0174] The term "midsole" as used in the present disclosure may be referred to as a layer of material that may be located between an outsole of a shoe, e.g., the bottom part of the sole that makes contact with the ground, and an upper of a shoe, e.g., the part of the shoe that covers the top of a foot of a wearer.

[0175] The term "outsole" as used in the present disclosure may be the bottom portion of the sole that comes at least partially into direct contact with the ground. This means that not the overall outsole must necessarily contact the ground, although this may often be the case. The outsole may offer several advantages that contribute to the overall performance, comfort, grip, durability, stability, and support, water, and weather resistance of the sole.

[0176] The term "medial", "medial side", "medial side region", and / or "medial side portion" of a sole / midsole as used herein may refer to an inner side and / or inner edge of the sole / midsole. This side and / or edge may be closest to a centerline of the body of the wearer, when the shoe comprising the sole is worn. This side and / or edge may extend from a big toe portion to a heel region. The term "medial side portion" may additionally comprise a small region extending from the medial side towards a heel to toe midline of the sole. The "medial side" and / or "medial side portion" is usually positioned facing the arch of the foot and / or the big toe.

[0177] The term "lateral", "lateral side", "lateral side region", and / or "lateral side portion" of a sole / midsole as used herein may refer to an outer side and / or outer edge of the sole / midsole. This side and / or edge may be farther way from a centerline of the body of the wearer, when the shoe comprising the sole is worn. This side and / or edge may extend from a small toe portion to a heel region. The term "lateral side portion" may additionally comprise a small region extending from the lateral side towards a heel to toe midline of the sole.

[0178] The term "toe portion" and / or "toe region" of a sole / midsole as used herein may refer to the front part of the sole / midsole, e.g., the forefoot part of the sole / midsole, in which toes of the foot of the wearer can be received, when worn. The toes of the foot of the wearer may include the big toe, and / or of the big toe knuckle. It may include an anterior end of the foot, when worn. Further, the toe portion and / or the toe region may include distal phalanges, intermedial phalanges and proximal phalanges of a foot of a wearer, when worn. The toe portion and / or the toe region may additionally include a frontal part of the metatarsal bones of a foot of a wearer, when worn.

[0179] The term "forefoot portion" and / or "forefoot region" of a sole / midsole may refer to the front portion of the sole / midsole. The forefoot portion / forefoot region of the sole / midsole shoe may cover an area of the foot corresponding to the toes and a base of the toes. In one example, the forefoot portion / forefoot region may cover less than about the front half of the underfoot portion. In one example, the forefoot portion / forefoot region may cover less than about one third of the underfoot portion in the front of the underfoot portion.

[0180] The term "midfoot portion" and / or "midfoot region" of a sole / midsole may refer to the central portion of the sole / midsole. The midfoot portion / midfoot region of the sole / midsole shoe may cover an area of the foot corresponding to the arch of the foot when the shoe comprising the sole / midsole is worn. In one example, the midfoot portion / midfoot region may cover less than about half of the underfoot portion, the central point of it being located approximately at half of the length along a heel to toe axis. In one example, the midfoot portion / midfoot region may cover less than about one third of the underfoot portion, the central point of it being located approximately at half of the length along a heel to toe axis.

[0181] The term "rearfoot portion" and / or "rearfoot region" of a sole / midsole may refer to the rear portion of the sole / midsole. The rearfoot portion / rearfoot region of the sole / midsole shoe may cover an area that corresponds to the heel and / or the surrounding region of the heel of the foot of a wearer when the shoe comprising the sole / midsole is worn. In one example, the rearfoot portion / rearfoot region may cover less than about the

rear half of the underfoot portion. In one example, the midfoot portion / midfoot region may cover less than about one third of the underfoot portion in the rear of the underfoot portion.

[0182] The term "forefoot portion" and / or "forefoot region" of a sole / midsole may refer to the front portion of the sole / midsole. The forefoot portion of the sole / midsole shoe may cover an area of the foot corresponding to the toes and a base of the toes. In one example, the forefoot portion may cover less than about half of the front of the underfoot portion or less than about one third of the underfoot portion.

[0183] The term "underfoot area" and / or "underfoot portion" of the sole / midsole as used herein may be determined for instance in a plane defined by a heel to toe axis and a medial to lateral axis of sole / midsole. In other words, the underfoot area / underfoot portion of the sole / midsole may be measured substantially in a horizontal plane, perpendicular to a vertical axis. The underfoot area / underfoot portion of the sole / midsole may be the area / portion with which the bottom of a foot of a wearer would come into contact (disregarding the present of an upper and / or an insole), when a shoe comprising such a sole is worn.

[0184] The term "upward direction" as used herein may be the direction from an underfoot portion of the upper to an upper portion of the upper. For instance, the upward direction may be the direction from the underfoot portion of the upper to an instep portion of the upper. The upward direction may be substantially parallel to a vertical axis.

[0185] The term "downward direction" as used herein may be directed substantially opposite to the upward direction.

[0186] The term "vertical axis" as used herein may substantially correspond to the wearer's main body axis from head to foot when the wearer stands on the ground.

[0187] Unless otherwise stated, the term "substantial" or "substantially" as used in the present context may be understood to a great or significant extent or for the most part or essentially. In particular, manufacturing tolerances are included by this term.

[0188] The term "and / or" is only an association relationship describing associated objects and represents that three relationships may exist. For example, A and / or B may represent three conditions: i.e., independent existence of A, existence of both A and B and independent existence of B. In addition, the character "/" in the disclosure usually represents that previous and next associated objects form an "or" relationship.

[0189] The terms "bottom", "top", "one end", "the other end", "outer side", "upper", "above", "inner side", "under", "below", "horizontal", "coaxial", "central", "end" "part", "length", "outer end" etc., which indicate the orientation or positional relationship, are based on the orientation or positional relationship shown in the drawings.

[0190] The terms "upper", "above", "below", "under" and the like as used in the present invention to indicate a relative position in space are used for the purpose of facilitating explanation to describe a sole for a shoe, an element, a part, an object and / or a feature shown in the drawings relative to the relationship of another sole for a shoe, element, part, object and / or feature.

Description of figures

[0191]

Fig. 1 shows an upper midsole layer 120 of a sole 101 for a shoe, in particular for a sports shoe, according to an embodiment of the present disclosure.

Fig. 2 shows a lower midsole layer 125 of a sole 101 for a shoe, in particular for a sports shoe, according to an embodiment of the present disclosure.

[0192] The sole 101 (in Fig. 1 and Fig. 2 not the complete sole 101 for a shoe is shown as understood by the skilled person) comprises: a midsole 110 comprising an upper midsole layer 120 and a lower midsole layer 125. As can be seen, the upper midsole layer 120 and the lower midsole 125 layer are at least partially distinct from one another. The sole 101 further comprises a shearing structure 130, arranged in the midsole 110. The shearing structure 130 is configured to allow a relative movement between the upper midsole layer 120 and the lower midsole layer 125.

[0193] The relative movement between the upper midsole layer 120 and the lower midsole layer 125 may be in a plane defined by a medial to lateral axis ML of the sole 101 and a heel to toe axis HT of the sole 101. In particular, the relative movement between the upper midsole layer 120 and the lower midsole layer 125 may be substantially parallel to a heel to toe axis HT of the sole 101. The heel to toe axis HT of the sole 101 and the medial to lateral axis ML of the sole 101 are indicated in Fig. 1 and Fig. 2.

[0194] It is noted that Fig. 1 and Fig. 2 show that the upper midsole layer 120 and the lower midsole layer 125 are distinct from one another, in the meaning that they are separate from one another. Nevertheless, and described elsewhere in greater detail, the upper midsole layer 120 and the lower midsole layer 125 can be at least partially distinct from one another. For instance, they may be partially attached to one another and / or at least partially integrally formed.

[0195] The shearing structure 130 can be configured to allow the relative movement between the upper midsole layer 120 and the lower midsole layer 125 in at least one of a forefoot portion 111 of the midsole 110, a midfoot portion 112 of the midsole 110, a rearfoot portion 113 of the midsole 110, a lateral portion (in proximity to reference sign 102 indicating the lateral side of the midsole 110) of the midsole 110 and / or a medial portion (in proximity of reference sign 103 indicating the medial side of the midsole 110) of the midsole 110.

[0196] The shearing structure 130 can be configured to allow the relative movement between the upper midsole layer 120 and the lower midsole layer 125 in at least one

of a forefoot portion 111 of the midsole 110 and a midfoot portion 112 of the midsole 110, such as a lateral forefoot portion 111a of the midsole 110, a medial forefoot portion 111b of the midsole 110, a lateral midfoot portion 112a of the midsole 110, and a medial midfoot portion 112b of the midsole 110. The shearing structure 130 can be configured to allow the relative movement between the upper midsole layer 120 and the lower midsole layer 125 in the lateral forefoot portion 111a of the midsole 110 and a lateral midfoot portion 112a of the midsole 110.

[0197] The lateral forefoot portion 111a of the midsole 110 and the lateral midfoot portion 112a of the midsole 110 are schematically indicated by the dashed boxes in Fig. 1 and Fig. 2. As understood by the skilled person, the boxes are of schematic nature and their precise extent can vary. Further, also the forefoot portion 111 of the midsole 110, the midfoot portion 112 of the midsole 110, and the rearfoot portion 113 of the midsole 110 are schematically indicated by way of brackets. Also, their precise extent can vary as understood by the skilled person.

[0198] It is noted that Fig. 1 and Fig. 2 do not depict the complete sole 101. Nevertheless, a part of the sole 101 is depicted. Therefore, the reference sign 101 is also provided in Fig. 1 and Fig. 2 to support an understanding thereof.

[0199] As can be seen, the shearing structure 130 comprises an upper shearing structure 131 on the upper midsole layer 120 and a lower shearing structure 136 on the lower midsole layer 125. The upper shearing structure 131 and the lower shearing structure 136 are facing one another, when assembled (as best seen in Fig. 3). As will be understood by the skilled person, when the sole 101 is not assembled, the upper shearing structure 131 and the lower shearing structure 136 may not be facing one another. Further, the upper shearing structure 131 and the lower shearing structure 136 can be arranged in any portion 111, 112, 113 of the midsole 110. Fig. 1 and Fig. 2 show that the upper shearing structure 131 and the lower shearing structure 136 are arranged in a forefoot portion 111 of the midsole 110 and in a midfoot portion 112 of the midsole 110. In particular, as indicated by the dashed boxes, the upper shearing structure 131 and the lower shearing structure 136 are arranged in a lateral forefoot portion 111a of the midsole 110 and in a lateral midfoot portion 112a of the midsole 110. However, this is merely an example and various arrangements are encompassed by the present disclosure.

[0200] The upper shearing structure 131 and the lower shearing structure 136 are at least partially engaged with one another, when assembled (as best seen in Fig. 3). Further, the upper shearing structure 131 and the lower shearing structure 136 are substantially shaped in correspondence to one another. For instance, one of them may form a negative form of a geometry with respect to the other one. The upper shearing structure 131 and the lower shearing structure 136 are engaged with one another via a form-fit connection, when assembled (as best seen in Fig. 3). It is noted that the form-fit connection only refers to the shape of the upper shearing structure 131 and the lower shearing structure 136 when there are substantially not forces acting on the sole 101. In particular, the form-fit connection is not to be confused with a rigid connection. Rather, shearing movement is well encompassed by it as described elsewhere herein in greater detail.

[0201] Further, as shown in Fig. 1 and Fig. 2, the upper shearing structure 131 is integrally formed with the upper midsole layer 120 and the lower shearing structure 136 is integrally formed with the lower midsole layer 125.

[0202] Integrally forming the respective structures 131 and 136, may also be known as forming them as one unitary piece. This may offer several advantages. For instance, strength and durability may be enhanced, since unitary pieces may often have fewer points of weakness and / or potential failure compared to assemblies of multiple components. This may result in increased overall strength and durability. Further, unitary pieces may be simpler and easier to manufacture and / or to assemble because they may substantially eliminate the need for separate parts, fasteners, or connectors, although this is not precluded. This may also lead to cost savings in production. Moreover, unitary pieces can reduce the overall weight of the resulting structure and / or product. This may be particularly advantageous in the context of the sole 101 for a shoe as proposed in here, where weight savings may play a significant role. Further, unitary pieces may provide improved performance as wear, vibration, noise associated with separate moving parts, or the like may be reduced. Further, by eliminating the need for additional components, parts, elements, or the like, the upper shearing structure 131 being integrally formed with the upper midsole layer 120 and the lower shearing structure 136 being integrally formed with the lower midsole layer 125 may reduce material costs, labor costs, and / or assembly time. In addition, fewer components may often mean simplified constructions, which could lead to reduced waste of material during production and disposal. This may contribute to a more sustainable and eco-friendlier sole 101.

[0203] However, as described elsewhere, also a separate construction, i.e., not integrally forming the upper shearing structure 131 with the upper midsole layer 120 and the lower shearing structure 136 with the lower midsole layer 125 may have advantages. For instance, providing for separate pieces instead of providing integrally formed ones can facilitate more complex arrangements. In addition, further functionalities may be more easily imparted. Thereby, the choice between integrally forming the elements 131 with 120 and the elements 136 with 125 and providing separate elements may depend on various factors such as the intended use, manufacturing processes, material properties, desired outcome, desired functionalities and / or cost considerations.

[0204] It is noted that a portion of the upper midsole layer 120 and a portion of the lower midsole layer 125 can

be fixedly attached to one another. This is appreciated as the shearing movement of the upper midsole layer 120 and the lower midsole layer 125 may require some attachment. The portion of the upper midsole layer 120 and the portion of the lower midsole layer 125 may be fixedly attached to one another by any kind of suitable means for attachment including but not limited to one or more and / or a combination of the following: adhesive bonding, cementing, stitching, use of mechanical fasteners, injection molding, welding, thermal bonding, compression molding, laminating, foam bonding, direction injection processing, foam encapsulation, molded construction, welded seam bonding or the like. It is understood that the choice of the means for attachment may depend on various factors like the type of sole 101 for the shoe, the materials used, the desired level of flexibility, and / or the manufacturing process employed. Each means for attachment may offer its own advantages and may be selected based on the specific requirements of the sole 101.

[0205] It may be the case that the size of the area of the upper midsole layer 120 and the lower midsole layer 125 that is fixedly attached may depend on the size of the shearing structure 130. That may be the case, because a maximum allowable frictional force due to the relative movement may pertain. It is believed that the maximum allowable frictional force can be increased at least partially by way of fixedly attaching a portion of the upper midsole layer 120 and a portion of the lower midsole layer 125. In one example, about at least 10 %, preferably at least 15 %, more preferably at least 20 %, even more preferably at least 25 %, even more preferably at least 30 %, even more preferably at least 35 %, even more preferably at least 40 %, even more preferably at least 45 %, even more preferably at least 50 % or more of the underfoot area of the midsole 110 may be fixedly attached to one another. Alternatively, or additionally, about at most 90 %, preferably at most 85 %, more preferably at most 80 %, even more preferably at most 75 %, even more preferably at most 70 %, even more preferably at most 65 %, even more preferably at most 60 %, even more preferably at most 55 %, even more preferably at most 50 % or less of the underfoot area of the midsole 110 may be fixedly attached to one another. In Fig. 1 and Fig. 2, the two-dimensional projection of the depicted upper midsole layer 120 or the depicted lower midsole layer 125 into the horizontal plane may be form the underfoot area of the midsole 110.

[0206] It is noted that, when the shearing structure 130 is provided in a forefoot portion 111 of the midsole 110, the rearfoot portion 113 of the midsole 110 and / or at least a part of the midfoot portion 112 of the midsole 110 may be at least partially fixedly attached to one another. In other words, the upper midsole layer 120 and the lower midsole layer 125 may be fixedly attached to one another at portions where the shearing structure 130 is not arranged.

[0207] **Fig. 3** shows a sole for a shoe, in particular for a sports shoe, according to an embodiment of the present disclosure. Fig. 3 shows the embodiments of Fig. 1 and Fig. 2 in an assembled condition.

[0208] The one or more upper protrusions 132 and / or the one or more lower protrusions 137 (which are described in greater detail in Fig. 4) have a maximum height h perpendicular to a horizontal plane of the sole 101 of at least 2 mm and / or of at most 20 mm as described elsewhere herein.

[0209] Fig. 3 also shows that the shearing structure 130 comprises a hollow space 135. The hollow space 135 is free from the upper midsole layer 120 and / or the lower midsole layer 125. It is understood that the hollow space 130 may vary in shape and size under a pressure load on the sole 101.

[0210] The hollow space 135 may be formed between the one or more upper protrusions 132 when received in the one or more lower recesses 138 (and / or between the one or more lower protrusions 137 when received in the one or more upper recesses 133). Thereby, the hollow space 135 may adopt a similar shape as the line segments (e.g., a zigzag line segment, a sawtooth line segment or the like) described elsewhere in here. This may have the further advantages that ventilation, cooling, aesthetics, functionality, and / or the like may be improved. For instance, the foot of the wearer can be subjected to greater ventilation which can reduce accumulation of moisture. This also improves longevity of the sole 101. In addition, when the hollow space 135 is fully exposed to the outside, the hollow space may be designed such that essentially no disturbing objects from the environment, such as pebbles or the like, can accumulate therein and / or can protrude therethrough. Thereby, the wearer's performance may not be deteriorated and / or the attention of the wearer is not disturbed.

[0211] Further, the shearing structure 130 can comprise a solid material, such as foam material. In the embodiment of Fig. 3, this may be understood such that a part of the upper shearing structure 131 that is integrally formed with the upper midsole layer 120 comprises a solid material, such as foam material. Further, also a part of the lower shearing structure 136 that is integrally formed with the lower midsole layer 125 comprises a solid material, such as foam material.

[0212] Fig. 3 also shows that the shearing structure 130 is at least partially visible as seen from outside. In particular, the shearing structure 130 is visible from a lateral side 102 of the midsole 110 (as indicated in Fig. 3) and / or from a medial side 103 of the midsole 110. The shearing structure may have a sawtooth shape 139 as seen from outside, preferably from a lateral side 102 of the midsole 110 and / or a medial side 103 of the midsole 110. In Fig. 3 the direction of viewing may be from a lateral forefoot portion 111a of the midsole 110. Visibility of the shearing structure 130 may be particularly important as one may be able to easily assess a condition of the shearing structure 130, such as a solidity, firmness or the like may be advantageous.

[0213] The one or more protrusions 132, 137 (as described in detailed in Fig. 4) can have an inclined surface as shown in Fig. 3 towards a neighboring recess 133, 138 as seen along the heel to toe axis HT, the inclined surface may be substantially continuous.

[0214] Although not shown Fig. 3figure, the sole 101 may further comprise an outsole arranged below the midsole 110, preferably below the lower midsole layer 125. As also understood, the sole 101 as described in here, may be attached to an upper to form a shoe, in particular a sports shoe, such as a running shoe. The upper may be attached to the sole 101 by any suitable means of attachment including but not limited to cementing / adhesive bonding, stitching, injection molding, or the like.

[0215] **Fig. 4** shows detailed views of Fig. 1 and Fig. 2.

[0216] As can be seen, the upper shearing structure 131 comprises one or more upper protrusions 132 and the lower shearing structure 136 comprises one or more lower recesses 138. Further, the lower shearing structure 136 comprises one or more lower protrusions 137 and the upper shearing structure 131 comprises one or more upper recesses 133. An upper protrusion 132 may extend from a lateral side 102 of the midsole 110 to about a midline 106 (indicated as a dashed line in the upper part of Fig. 2) of the midsole 110, the midline 106 being substantially parallel to a heel to toe axis HT of the sole 101. Similarly, also an upper recess 133, a lower protrusion 137, and / or a lower recess 138 may extend from a lateral side 102 of the midsole 110 to about a midline 106 of the midsole 110. As noted elsewhere, in case the shearing structure 130 is provided on a medial side 103, the protrusions 132, 137 and / or recesses 133, 138 may extend from a medial side 103 of the midsole 110 to about a midline 106 of the midsole 110. However, a plurality of different arrangements of the shearing structure 130 are possible as noted elsewhere in here.

[0217] The one or more upper protrusions 132 are at least partially accommodated in the one or more lower recesses 138, when assembled. Further, the one or more lower protrusions 137 are at least partially accommodated in the one or more upper recesses 133, when assembled (as best seen in Fig. 3).

[0218] In Fig. 4, it is indicated that the one or more upper protrusions 132 and / or the one or more lower protrusions 137 are spaced apart from one another as seen in a horizontal plane of the sole. In Fig. 4, the spacing w is indicated along a heel to toe axis HT of the sole 101.

[0219] The one or more upper protrusions 132 and / or the one or more lower protrusions 137 can be spaced apart from one another as seen along a heel to toe axis HT of the sole 101 by the distance w, wherein the distance w is at least 1 cm, preferably at least 1.5 cm, more preferably at least 2 cm, even more preferably at least 2.5 cm, most more preferably at least 3 cm, and / or wherein w is at most 8 cm, preferably at most 6 cm, more preferably at most 5 cm, even more preferably at most 4 cm, further more preferably at most 3.5 cm, most preferably at most 3 cm.

[0220] The one or more upper protrusions 132 and the one or more upper recesses 133 are arranged in an alternating manner as seen along a heel to toe axis HT of the sole 101. Same applies to the one or more lower protrusions 137 and the one or more lower recesses 138.

[0221] In one example, the one or more upper protrusions 132 and the one or more upper recesses 133 may be arranged arbitrarily. This may have the advantage that the protrusions 132 and recesses 133 can be arranged in such a manner that they increase shearing if this is desired in some applications of the sole 101. As understood, the arrangement of the upper protrusions 132 and of the upper recesses 133 may vary depending on the type of sole 101 and its use case.

[0222] The one or more upper protrusions 132 and / or the one or more lower protrusions 137 have an elongated shape, wherein the longitudinal axis is substantially parallel with a medial to lateral axis ML of the sole 101.

[0223] The one or more upper protrusions 132 and / or the one or more lower protrusions 137 have a shape as seen in a horizontal plane of the sole 101 comprising one or more of a line segment defined by a mathematical function, in particular a periodic mathematical function, such as a sine wave, a line segment of a zigzag, a line segment of a sawtooth. In Fig. 4, the shape is a zigzag or sawtooth shape.

[0224] Without wishing to be bound by theory, it is believed that these shapes allow for improved control of the movement of the one or more upper protrusions 132 and / or the one or more lower protrusions 137. For instance, a movement along the medial to lateral axis ML may be substantially prevented by way of an interlocking of the corresponding shapes. Nevertheless, shearing movement along the heel to toe axis HT is still allowed by way of the shearing structure 130. Thus, kinetic energy can be significantly reduced. In this manner, it is still possible that internal solid body deformation also contributes to a reduction of the kinetic energy; however, the contribution of the shearing structure 130 due to shearing movement and its corresponding friction and the generation of heat may, in one example, be greater compared to the solid body deformation. In addition, a defined stop may be provided along the heel to toe axis HT of the sole 101. This may increase safety, as there is a defined stop, which prevents any instability of the sole 101. All these advantages may equally apply to the shapes as specified in there. The shapes may be understood in greater detail as follows:

A zigzag line may be a pattern or path characterized by a series of substantially sharp angles or turns. The pattern or path may create a repeating "Z" shape and / or a series of interconnected diagonal lines. Next to the added benefits of their function, zigzag lines may also contribute to the outer appearance and or haptic of the protrusion 132, 137.

[0225] A sawtooth line may be a geometric pattern or

waveform that may resemble the teeth of a saw blade. It may be characterized by a series of linear, j agged peaks and troughs. Each peak may form a sharp angle and each trough may form a corresponding sharp angle in the opposite direction. This may create a repeating pattern that may resemble the teeth of a saw.

[0226] It is noted that a line segment defined by a mathematical function may also contribute to enhance the advantages of the protrusions 132, 137.

[0227] Further, any kind of shape of the one or more upper protrusions 132 and / or the one or more lower protrusions 137 may be encompassed by the present disclosure, for instance one or more of the following non exhaustive list: rectangles, triangles, any periodic function, any form allowing horizontal movement of upper midsole layer 120 and the lower midsole layer 125.

[0228] As shown in Fig. 4, the upper shearing structure 131 can have five protrusions 132. The left most protrusion 132 has two zigzags or saw teeth. The three protrusions 132 in the middle have three zigzags or saw teeth. The right most protrusion 132 has two zigzags or saw teeth. Depending on what may precisely be understood as one zigzag or sawtooth, the number may slightly vary as understood by the skilled person. The number of zigzags or saw teeth of the lower protrusions 137 are like the ones of the upper protrusions 132 as shown in the lower part of Fig. 4.

[0229] The one or more upper protrusions 132 and / or the one or more lower protrusions 137 comprise one or more side surfaces 134 (merely one side surface 134 is indicated for brevity). The normal of the side surface 134 can be substantially parallel to a horizontal plane of the sole 101. The side surface 134 is angled with respect to a medial to lateral axis ML (additionally indicated by a dashed line in the lower part of Fig. 4) of the sole 101 as indicated in Fig. 4. The angle α can be at least 5° and / or at most 80° as described elsewhere herein. A preferred range of the angle α may be about 30° to about 60°.

[0230] It is noted that the bracket of reference numeral 130 means that the upper shearing structure 131 and the lower shearing structure 136 are comprised by the shearing structure 130.

[0231] **Fig. 5** shows a sole plate 140 for a sole 101 for a shoe, in particular for a sports shoe, according to an embodiment of the present disclosure from two different sides. The top part of Fig. 5 shows the sole plate 140 with an upper surface 141 of the sole plate 140 facing the direction of viewing. The bottom part of Fig. 5 shows the sole plate 140 with a lower surface 142 of the sole plate 140 facing the direction of viewing.

[0232] The sole plate 140 is provided between the upper midsole layer 120 and the lower midsole layer 125, when the sole 101 is assembled. The sole plate 140 is configured to control relative the movement between the upper midsole layer 120 and the lower midsole layer 125.

[0233] The sole plate 140 may be attached to the upper midsole layer 120 and / or the lower midsole layer 125. Any kind of suitable means for attachment are possible and encompassed by the present disclosure. In one example, the sole plate 140 may be cemented to the upper midsole layer 120 and / or the lower midsole layer 125. In another example, the sole plate 140 may be substantially attached to the upper midsole layer 120 and / or the lower midsole layer 125 by means of interlocking, form-fitting, or the like. This could be combined with additional means for attachment such as fasteners, adhesives or the like.

[0234] In one example, the sole plate 140 may comprise TPU. This may offer good sustainability, provides a high flexibility, and shows an improved longitudinal bending behavior. However, the sole plate 140 may alternatively or additionally comprise different materials including but not limited to rubber, plastic, or metal. The selection of the material may depend on the type of shoe and its intended use.

[0235] The sole plate 140 comprises projections 144 and / or indentations 143 that are engaged with corresponding indentations 126 (as best seen in Fig. 2) and / or projections 121 (as best seen in Fig. 1) provided in the lower midsole layer 125 and / or the upper midsole layer 120.

[0236] The projections 144 of the sole plate 140 are at least partially hollow and / or at least partially filled with foam. The sole plate 140 is elongated and arranged along a heel to toe axis HT of the sole 101. Also, the indentations 126 and / or the projections 121 provided in the lower midsole layer 125 and / or the upper midsole layer 120 are elongated and arranged along a heel to toe axis HT of the sole 101. The indentations 143, 126 and / or projections 144, 121 have a substantially half circular profile or circular segment profile as seen along a heel to toe axis HT.

[0237] A circular segment profile may be a two-dimensional geometric shape that is formed by taking a portion of a circle's circumference and the chord (a straight line segment that connects two points on the circle's circumference) that spans the arc of the segment. Essentially, the circular segment may be the curved region between a circular arc and the two radii (lines connecting the center of the circle to the endpoints of the arc) that define the arc.

[0238] In one example, indentations 143 may be provided on an upper surface 141 of the sole plate 140. In one example, protrusions 144 may be provided on a lower surface 142 of the sole plate 140. The indentations 143 and / or protrusions 144 may be integrally formed with the sole plate 140. In other examples, they may be attached by means of adhesives, such as gluing.

[0239] Fig. 5 also shows that the sole plate 140 comprises a stopping element 145 arranged obliquely with respect to the projections 144 and / or indentations 143 of the sole plate 140. The stopping element 145 is arranged in a toe portion 111c (as schematically indicated by the bracket of Fig. 5) of the forefoot portion 111 of the midsole 110.

[0240] As can be imagined by way of the indentations

126 of the lower midsole layer 125 shown in Fig. 2, the sole plate 140 extends along the complete length l (as best seen in Fig. 4) of the shearing structure 130 as seen in a heel to toe axis HT of the sole 101. It is noted that the complete length l of the shearing structure 130 is schematically indicated in Fig. 4.

[0241] **Fig. 6** shows an upper midsole layer 120 and a lower midsole layer 125 of a sole 101 for a shoe, in particular for a sports shoe, and a sole plate 140 for a sole 101 for a shoe according to an embodiment of the present disclosure. The depicted embodiment in Fig. 6 is similar to any other embodiment described in the present disclosure, meaning that any features described in any other embodiment may also be applicable to the embodiment of Fig. 6 as far as technically meaningful. Same applies vice vera. It is noted that not all features of the other embodiments are repeated and / or indicated in the embodiment of Fig. 6 for brevity only.

[0242] The sole 101 (in Fig. 6 not the complete sole 101 for a shoe is shown as understood by the skilled person) comprises: a midsole 110 comprising an upper midsole layer 120 and a lower midsole layer 125. The upper midsole layer 120 and the lower midsole 125 layer are at least partially distinct from one another. The sole 101 further comprises a shearing structure 130, arranged in the midsole 110. The shearing structure 130 is configured to allow a relative movement between the upper midsole layer 120 and the lower midsole layer 125, preferably along the heel to toe axis HT.

[0243] As can be seen, the shearing structure 130 comprises an upper shearing structure 131 on the upper midsole layer 120 and a lower shearing structure 136 on the lower midsole layer 125. The upper shearing structure 131 and the lower shearing structure 136 are facing one another, when assembled.

[0244] Further, the sole 101 comprises a sole plate 140 provided between the upper midsole layer 120 and the lower midsole layer 125, when the sole 101 is assembled. The sole plate 140 is configured to control relative the movement between the upper midsole layer 120 and the lower midsole layer 125. The sole plate 140 comprises a stopping element 145 arranged obliquely with respect to the heel to toe axis HT of the sole plate 140. The stopping element 145 is arranged in a toe portion of the forefoot portion of the midsole 110.

[0245] **Fig. 7** shows a shoe 100, in particular a sports shoe, comprising a sole 101 and a sole plate 140 according to an embodiment of the present disclosure. Fig. 7 shoes the shoe 100 from a lateral side 102. **Fig. 7a** shows the embodiments of Fig. 7 form the medial side 103. The depicted embodiment in Fig. 7 is similar to any other embodiment described in the present disclosure, meaning that any features described in any other embodiment may also be applicable to the embodiment of Fig. 7 as far as technically meaningful. Same applies vice vera. It is noted that not all features of the other embodiments are repeated and / or indicated in the embodiment of Fig. 7 for brevity only. The shoe 100 of Fig. 7 is depicted in an assembled condition.

[0246] The depicted shoe 100 can be a sports shoe, such as a running shoe, in particular a shoe for downhill running. The shoe 100 comprises a sole 101 according to any one of the embodiments described in here. Further, the shoe 100 comprises an upper 150 attached to the sole 100. As in the foregoing embodiments, the sole 101 of the embodiment of Fig. 7 comprises: a midsole 110 comprising an upper midsole layer 120 and a lower midsole layer 125. The sole 101 further comprises a shearing structure 130, arranged in the midsole 110. The shearing structure 130 is configured to allow a relative movement between the upper midsole layer 120 and the lower midsole layer 125, preferably along the heel to toe axis HT. The shearing structure 130 comprises an upper shearing structure 131 on the upper midsole layer 120 and a lower shearing structure 136 on the lower midsole layer 125. The upper shearing structure 131 and the lower shearing structure 136 are facing one another.

[0247] Further, one or more upper protrusions 132 and one or more lower protrusions 137 are indicted in Fig. 7 and Fig. 7a (not all protrusions are indicated for brevity).

[0248] Moreover, the sole 101 comprises a sole plate 140 arranged between the upper midsole layer 120 and the lower midsole layer 125. As best seen in Fig. 7a, the sole plate 140 is visible from outside the shoe 100.

[0249] In any of the embodiments of the sole 101 for a shoe as described herein, the upper midsole layer 120 may comprise a first material and the lower midsole layer 125 may comprises a second material, wherein the first material is different than the second material, or wherein the first material is substantially the same as the second material.

[0250] As an example, the first material and the second material may be provided with a different stiffness. This can provide for an improved distribution of the forces to an outsole of the sole 101 and / or to the ground.

[0251] The "stiffness" as referred to herein may be understood as rigidity or modulus of elasticity. It may refer to a material's ability to resist deformation when subjected to an applied force. It may describe how much a material will deflect or stretch in response to an applied load. A stiffer material may experience less deformation under the same load compared to a less stiff material. Stiffness is measured by Young's modulus, which quantifies the relationship between stress (force per unit area) and strain (deformation). Stiffness may often be associated with a material's ability to maintain its shape and resist bending or flexing.

[0252] In any of the embodiments of the sole 101 for a shoe as described herein, the midsole 110, in particular the upper midsole layer 120 and / or the lower midsole layer 125, comprises or consists of a particle foam material, in particular a particle foam material comprising particles of expanded thermoplastic polyurethane, eTPU, particles of expanded polyamide, ePA, particles of expanded polyether-block-amide, ePEBA, and / or particles of expanded thermoplastic polyester ether elas-

tomer, eTPEE.

[0253] In any of the embodiments of the sole 101 for a shoe as described herein, the midsole 110, in particular the upper midsole layer 120 and / or the lower midsole layer 125, comprises or consists of a homogeneous foam material.

[0254] Homogeneous foam materials or homogeneous foams are known to the skilled person. In some instances, they are referred to as polymer foams, plastic foams. These foams are produced by injection molding or compression molding, for example. In case a mold is used, liquefied polymer material, which may contain a blowing agent, is typically placed in a mold cavity and a process of foaming the polymer material takes place within the mold cavity. Homogeneous foams typically do not have a recognizable granular structure, i.e., they substantially do not have any identifiable particles within the finished foam.

[0255] Particle foam materials or particle foams on the other hand is different compared to homogeneous foam. To produce particle foam, expanded particles (or beads) are created in a first step from a particulate base material that is foamed. These expanded beads can then be assembled in a second step to form a coherent structure in which the individual particle boundaries are discernible, i.e., clearly visible, in the finished foam. Expanded in this context means that each individual particle has a core of foamed material with many small foam cells, i.e., the particle may not consist of a compact, solid material.

[0256] It is noted that any one or more of the embodiments described herein and / or examples may be combined with further aspects as described herein and details of the embodiments and / or examples may also be omitted, as will be understood by the skilled person. The scope of protection is determined by the claims and is not limited by the embodiments and / or examples disclosed in the above figures.

6. Further embodiments

[0257] The invention is further described by the following embodiments:

1. A sole (101) for a shoe, in particular for a sports shoe, such as a running shoe, the sole (101) comprising:

a midsole (110) comprising an upper midsole layer (120) and a lower midsole layer (125), the upper midsole layer (120) and the lower midsole layer (125) being at least partially distinct from one another; and
a shearing structure (130), arranged in the midsole (110);
wherein the shearing structure (130) is configured to allow a relative movement between the upper midsole layer (120) and the lower midsole layer (125).

2. The sole (101) for a shoe according to embodiment 1, wherein the relative movement between the upper midsole layer (120) and lower midsole layer (125) is in a plane defined by a medial to lateral axis (ML) of the sole (101) and a heel to toe axis (HT) of the sole (101),
wherein the relative movement between the upper midsole layer (120) and lower midsole layer (125) is preferably substantially parallel to a heel to toe axis (HT) of the sole (101).

3. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the shearing structure (130) is configured to allow the relative movement between the upper midsole layer (120) and the lower midsole layer (125) in at least one of a forefoot portion (111) of the midsole (110), a midfoot portion (112) of the midsole (110), a rearfoot portion (113) of the midsole (110), a lateral portion of the midsole (110) and a medial portion of the midsole (110),

preferably in at least one of a forefoot portion (111) of the midsole (110) and a midfoot portion (112) of the midsole (110), such as a lateral forefoot portion (111a) of the midsole (110), a medial forefoot portion (111b) of the midsole (110), a lateral midfoot portion (112a) of the midsole (110), and a medial midfoot portion (112b) of the midsole (110),
most preferably in at least one of a lateral forefoot portion (111a) of the midsole (110) and a lateral midfoot portion (112a) of the midsole (110).

4. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the shearing structure (130) comprises an upper shearing structure (131) on the upper midsole layer (120) and a lower shearing structure (136) on the lower midsole layer (125), wherein the upper shearing structure (131) and the lower shearing structure (136) are facing one another,
wherein the upper shearing structure (131) and the lower shearing structure (136) are preferably arranged in a forefoot portion (111) of the midsole (110) and / or a midfoot portion (112) of the midsole (110), most preferably in a lateral forefoot portion (111a) of the midsole (110) and / or a lateral midfoot portion (112a) of the midsole.

5. The sole (101) for a shoe according to embodiment 4, wherein the upper shearing structure (131) and the lower shearing structure (136) are at least partially engaged with one another.

6. The sole (101) for a shoe according to any one of the preceding embodiments 4 or 5, wherein the

upper shearing structure (131) and the lower shearing structure (136) are substantially shaped in correspondence to one another.

7. The sole (101) for a shoe according to any one of the preceding embodiments 4 to 6, wherein the upper shearing structure (131) and the lower shearing structure (136) are engaged with one another via a form-fit connection.

8. The sole (101) for a shoe according to any one of the preceding embodiments 4 to 7, wherein the upper shearing structure (131) is integrally formed with the upper midsole layer (120) and the lower shearing structure (136) is integrally formed with the lower midsole layer (125).

9. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the upper shearing structure (131) comprises one or more upper protrusions (132) and the lower shearing structure (136) comprises one or more lower recesses (138), and / or
wherein the lower shearing structure (136) comprises one or more lower protrusions (137) and the upper shearing structure (131) comprises one or more upper recesses (133).

10. The sole (101) for a shoe according to embodiment 9, wherein the one or more upper protrusions (132) are at least partially accommodated in the one or more lower recesses (138), and / or
wherein the one or more lower protrusions (137) are at least partially accommodated in the one or more upper recesses (133).

11. The sole (101) for a shoe according to any one of the preceding embodiments 9 or 10, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) are spaced apart (w) from one another as seen in a horizontal plane of the sole (101), preferably as seen along a heel to toe axis (HT) of the sole (101).

12. The sole (101) for a shoe according to embodiment 11, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) are spaced apart (w) from one another as seen in a horizontal plane of the sole (101), preferably as seen along a heel to toe axis (HT) of the sole (101), by at least 1 cm, preferably at least 1.5 cm, more preferably at least 2 cm, even more preferably at least 2.5 cm, most more preferably at least 3 cm, and / or
by at most 8 cm, preferably at most 6 cm, more preferably at most 5 cm, even more preferably at most 4 cm, further more preferably at most 3.5 cm, most preferably of at most 3 cm.

13. The sole (101) for a shoe according to any one of the preceding embodiments 9 to 12, wherein the one or more upper protrusions (132) and the one or more upper recesses (133) are arranged in an alternating manner, preferably as seen along a heel to toe axis (HT) of the sole (101).

14. The sole (101) for a shoe according to any one of the preceding embodiments 9 to 13, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) have an elongated shape, preferably having a longitudinal axis that is substantially parallel with a medial to lateral axis (ML) of the sole (101).

15. The sole (101) for a shoe according to any one of the preceding embodiments 9 to 14, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) have a shape as seen in a horizontal plane of the sole (101) comprising one or more of a line segment defined by a mathematical function, in particular a periodic mathematical function, such as a sine wave, a line segment of a zigzag, a line segment of a sawtooth.

16. The sole (101) for a shoe according to any one of the preceding embodiments 9 or 15, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) comprise one or more side surfaces (134), the normal of which being substantially parallel to a horizontal plane of the sole (101), the side surfaces (134) being angled with respect to a medial to lateral axis (ML) of the sole (101), preferably having an angle (α) of at least 5°, preferably at least 10°, more preferably at least 15°, even more preferably at least 20°, further more preferably at least 25°, further more preferably at least 30°, and / or
of at most 80°, preferably at most 60°, more preferably at most 55°, even more preferably at most 50°, further more preferably at most 45°, further more preferably at most 40°.

17. The sole (101) for a shoe according to any one of the preceding embodiments 9 to 16, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) have a maximum height (h) perpendicular to a horizontal plane of the sole (101) of at least 2 mm, preferably at least 3 mm, more preferably at least 5 mm, even more preferably at least 8 mm, most preferably at least 10 mm,
and / or of at most 20 mm, preferably at most 18 mm, more preferably at most 16 mm, even more preferably at most 14 mm, most preferably at most 12 mm.

18. The sole (101) for a shoe according to any one of the preceding embodiments, further comprising a

sole plate (140) provided between the upper midsole layer (120) and the lower midsole layer (125) configured to control relative the movement between the upper midsole layer (120) and the lower midsole layer (125).

19. The sole (101) for a shoe according to embodiment 18, wherein the sole plate (140) comprises projections (144) and / or indentations (143) that are engaged with corresponding indentations (126) and / or projections (121) provided in the lower midsole layer (125) and / or the upper midsole layer (120).

20. The sole (101) for a shoe according to any one of the preceding embodiments 18 or 19, wherein the projections (144) of the sole plate (140) are at least partially hollow and / or at least partially filled with foam.

21. The sole (101) for a shoe according to any one of the preceding embodiments 18 to 20, wherein the sole plate (140) is elongated and arranged along a heel to toe axis (HT), wherein the indentations (126) and / or projections (121) provided in the lower midsole layer (125) and / or the upper midsole layer (121) are also elongated and arranged along a heel to toe axis (HT) of the sole (101).

22. The sole (101) for a shoe according to any one of the preceding embodiments 18 to 21, wherein the indentations (143) and / or projections (144) of the sole plate (140) have a substantially half circular profile or circular segment profile, preferably as seen along a heel to toe axis (HT).

23. The sole (101) for a shoe according to any one of the preceding embodiments 18 to 22, wherein the sole plate (140) comprises a stopping element (145) arranged obliquely with respect to the projections (121) and / or indentations (126) of the sole plate (140), the stopping element (145) preferably being arranged in a toe portion (111c) of a forefoot portion (111) of the midsole (110).

24. The sole (101) for a shoe according to any one of the preceding embodiments 18 to 23, wherein the sole plate (140) extends along the complete length (l) of the shearing structure (130) as seen in a heel to toe axis (HT) of the sole (101).

25. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the shearing structure (130) comprises a hollow space (135), preferably being free from the upper midsole layer (120) and / or the lower midsole layer.

26. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the shearing structure (130) comprises a solid material, such as foam material.

27. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the shearing structure (130) is at least partially visible as seen from outside, preferably from a lateral side of the midsole (110) and / or a medial side of the midsole (110), more preferably from a lateral forefoot portion (111a) of the midsole (110) and / or a medial forefoot portion (111b) of the midsole (110).

28. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the shearing structure (130) has a sawtooth shape (139) as seen from outside, preferably from a lateral side of the midsole (110) and / or a medial side of the midsole (110), more preferably from a lateral forefoot portion (111a) of the midsole (110) and / or a medial forefoot portion (111b) of the midsole (110).

29. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the upper midsole layer (120) comprises a first material and the lower midsole layer (125) comprises a second material,

wherein the first material is different than the second material, or
wherein the first material is substantially the same as the second material.

30. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the midsole (110), in particular the upper midsole layer (120) and / or the lower midsole layer (125), comprises or consists of a particle foam material, in particular a particle foam material comprising particles of expanded thermoplastic polyurethane, eTPU, particles of expanded polyamide, ePA, particles of expanded polyether-block-amide, ePEBA, and/or particles of expanded thermoplastic polyester ether elastomer, eTPEE.

31. The sole (101) for a shoe according to any one of the preceding embodiments, wherein the midsole (110), in particular the upper midsole layer (120) and / or the lower midsole layer (125), comprises or consists of a homogeneous foam material.

32. The sole (101) for a shoe according to any one of the preceding embodiments, wherein a portion of the upper midsole layer (120) and a portion of the lower midsole layer (125) are fixedly attached to one another.

33. The sole (101) for a shoe according to any one of

the preceding embodiments, wherein the sole (101) further comprises an outsole arranged below the midsole (110), preferably below the lower midsole layer (125).

34. A shoe, in particular a sports shoe, such as a running shoe, the shoe comprising:

a sole according to any one of the preceding embodiments; and
an upper attached to the sole (101).

35. A sole (101) for a shoe, in particular for a sports shoe, such as a running shoe, the sole (101) comprising:

a midsole (110) comprising an upper midsole layer (120) and a lower midsole layer (125), the upper midsole layer (120) and the lower midsole layer (125) being integrally formed; and
a shearing structure (130), arranged in a midfoot portion (112) of the midsole (110) and / or a forefoot portion (111) of the midsole (110);
wherein the shearing structure (130) is configured to allow a relative movement between the upper midsole layer (120) and the lower midsole layer (125).

36. A method for manufacturing a sole (101) for a shoe, in particular for a sports shoe, such as a running shoe, preferably a shoe according to any one of the preceding embodiments 1 to 35, the method comprising:

providing a midsole (110) comprising an upper midsole layer (120) and a lower midsole layer (125), the upper midsole layer (120) and the lower midsole layer (125) being at least partially distinct from one another;
providing a shearing structure (130), arranged in the midsole (110);
wherein the shearing structure (130) is configured to allow a relative movement between the upper midsole layer (120) and the lower midsole layer (125).

7. List of reference signs used

[0258]

100 shoe
101 sole for a shoe
102 lateral side of the midsole
103 medial side of the midsole
106 midline of the midsole
110 midsole
111 forefoot portion of the midsole
111a lateral forefoot portion of the midsole
111b medial forefoot portion of the midsole
111c toe portion of a forefoot portion of the midsole
112 midfoot portion of the midsole
112a lateral midfoot portion of the midsole
112b medial midfoot portion of the midsole
113 rearfoot portion of the midsole
120 upper midsole layer
121 projections of the upper midsole layer
125 lower midsole layer
126 indentations of the lower midsole layer
130 shearing structure
131 upper shearing structure
132 upper protrusions
133 upper recesses
134 one or more side surfaces of the upper protrusions and / or the lower protrusions
135 hollow space of the shearing structure
136 lower shearing structure
137 lower protrusions
138 lower recesses
139 sawtooth shape of the shearing structure
w spacing between the upper protrusions and / or the lower protrusions
h height of one or more of the one or more upper protrusions and / or lower protrusions
l complete length of the shearing structure
140 sole plate
141 upper surface of the sole plate
142 lower surface of the sole plate
143 indentations of the sole plate
144 projections of the sole plate
145 stopping element
150 upper of the shoe
HT heel to toe axis (longitudinal direction) of the sole
ML medial to lateral axis of the sole
UD upward direction
DD upward direction
α angle between the side surfaces and a medial to lateral axis of the sole

Claims

1. A sole (101) for a shoe, in particular for a sports shoe, such as a running shoe, the sole (101) comprising:

a midsole (110) comprising an upper midsole layer (120) and a lower midsole layer (125), the upper midsole layer (120) and the lower midsole layer (125) being at least partially distinct from one another; and
a shearing structure (130), arranged in the midsole (110);
wherein the shearing structure (130) is configured to allow a relative movement between the upper midsole layer (120) and the lower midsole layer (125).

2. The sole (101) for a shoe according to claim 1, wherein the relative movement between the upper midsole layer (120) and lower midsole layer (125) is in a plane defined by a medial to lateral axis (ML) of the sole (101) and a heel to toe axis (HT) of the sole (101),
wherein the relative movement between the upper midsole layer (120) and lower midsole layer (125) is preferably substantially parallel to a heel to toe axis (HT) of the sole (101).

3. The sole (101) for a shoe according to any one of the preceding claims, wherein the shearing structure (130) is configured to allow the relative movement between the upper midsole layer (120) and the lower midsole layer (125) in at least one of a forefoot portion (111) of the midsole (110), a midfoot portion (112) of the midsole (110), a rearfoot portion (113) of the midsole (110), a lateral portion of the midsole (110) and a medial portion of the midsole (110),

preferably in at least one of a forefoot portion (111) of the midsole (110) and a midfoot portion (112) of the midsole (110), such as a lateral forefoot portion (111a) of the midsole (110), a medial forefoot portion (111b) of the midsole (110), a lateral midfoot portion (112a) of the midsole (110), and a medial midfoot portion (112b) of the midsole (110),
most preferably in at least one of a lateral forefoot portion (111a) of the midsole (110) and a lateral midfoot portion (112a) of the midsole (110).

4. The sole (101) for a shoe according to any one of the preceding claims, wherein the upper shearing structure (131) comprises one or more upper protrusions (132) and the lower shearing structure (136) comprises one or more lower recesses (138), and / or
wherein the lower shearing structure (136) comprises one or more lower protrusions (137) and the upper shearing structure (131) comprises one or more upper recesses (133).

5. The sole (101) for a shoe according to claim 4, wherein the one or more upper protrusions (132) are at least partially accommodated in the one or more lower recesses (138), and / or
wherein the one or more lower protrusions (137) are at least partially accommodated in the one or more upper recesses (133).

6. The sole (101) for a shoe according to claim 4 or 5, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) are spaced apart (w) from one another as seen in a horizontal plane of the sole (101), preferably as seen along a heel to toe axis (HT) of the sole (101).

7. The sole (101) for a shoe according to claim 6, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) are spaced apart (w) from one another as seen in a horizontal plane of the sole (101), preferably as seen along a heel to toe axis (HT) of the sole (101), by at least 1 cm, preferably at least 1.5 cm, more preferably at least 2 cm, even more preferably at least 2.5 cm, most more preferably at least 3 cm, and / or by at most 8 cm, preferably at most 6 cm, more preferably at most 5 cm, even more preferably at most 4 cm, further more preferably at most 3.5 cm, most preferably of at most 3 cm.

8. The sole (101) for a shoe according to any one of the preceding claims 4 to 7, wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) have an elongated shape, preferably having a longitudinal axis that is substantially parallel with a medial to lateral axis (ML) of the sole (101).

9. The sole (101) for a shoe according to any one of the preceding claims 4 to 8,
wherein the one or more upper protrusions (132) and / or the one or more lower protrusions (137) have a shape as seen in a horizontal plane of the sole (101) comprising one or more of a line segment defined by a mathematical function, in particular a periodic mathematical function, such as a sine wave, a line segment of a zigzag, a line segment of a sawtooth.

10. The sole (101) for a shoe according to any one of the preceding claims, further comprising a sole plate (140) provided between the upper midsole layer (120) and the lower midsole layer (125) configured to control relative the movement between the upper midsole layer (120) and the lower midsole layer (125).

11. The sole (101) for a shoe according to claim 10, wherein the sole plate (140) comprises projections (144) and / or indentations (143) that are engaged with corresponding indentations (126) and / or projections (121) provided in the lower midsole layer (125) and / or the upper midsole layer (120).

12. The sole (101) for a shoe according to claim 10 or 11, wherein the projections (144) of the sole plate (140) are at least partially hollow and / or at least partially filled with foam.

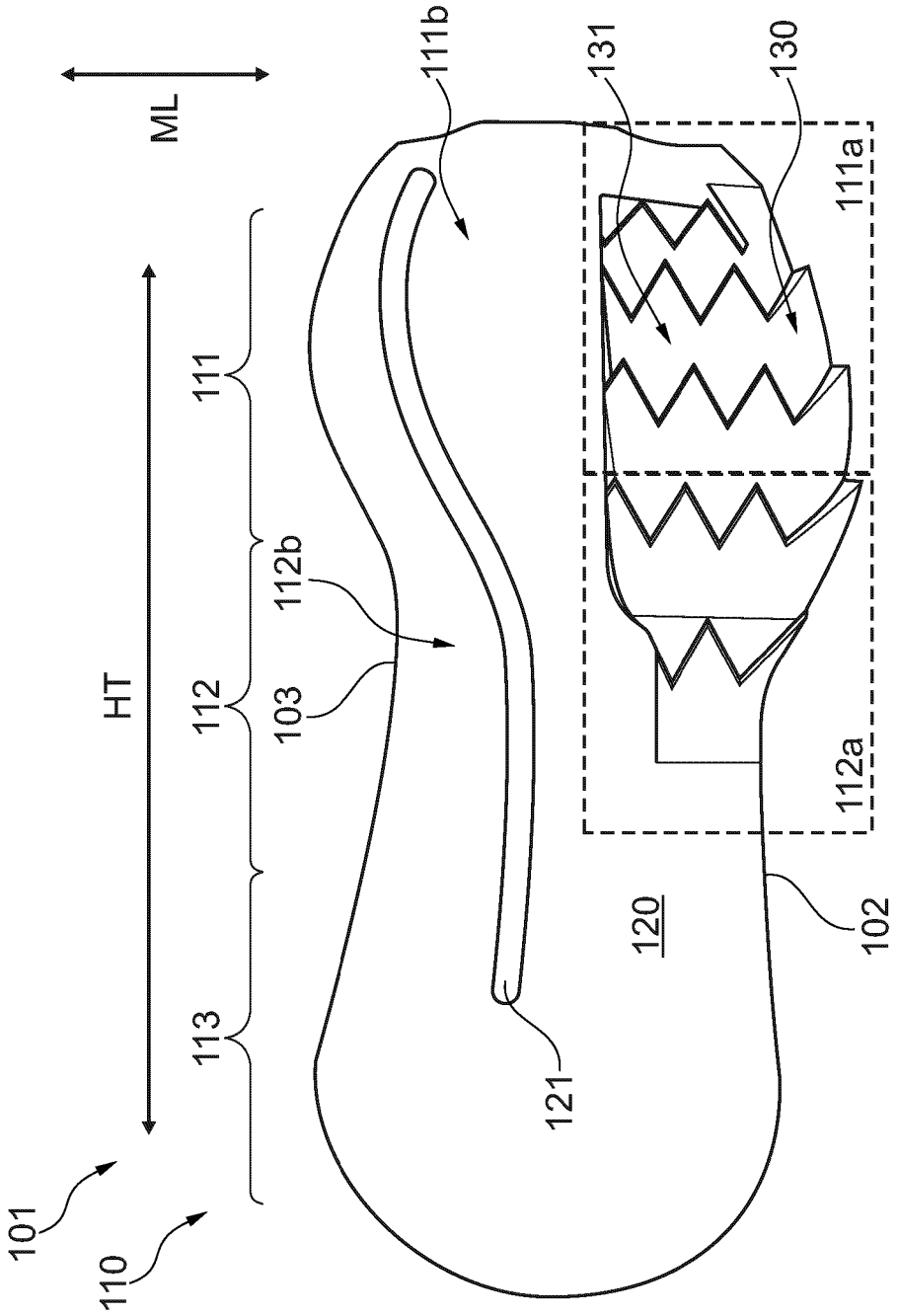
13. The sole (101) for a shoe according to any one of the preceding claims, wherein the shearing structure (130) comprises a hollow space (135), preferably being free from the upper midsole layer (120) and / or the lower midsole layer.

14. A shoe, in particular a sports shoe, such as a running shoe, the shoe comprising:

a sole according to any one of the preceding claims; and
an upper attached to the sole (101).

15. A method for manufacturing a sole (101) for a shoe, in particular for a sports shoe, such as a running shoe, preferably a shoe according to any one of the preceding claims 1 to 14, the method comprising:

providing a midsole (110) comprising an upper midsole layer (120) and a lower midsole layer (125), the upper midsole layer (120) and the lower midsole layer (125) being at least partially distinct from one another;
providing a shearing structure (130), arranged in the midsole (110);
wherein the shearing structure (130) is configured to allow a relative movement between the upper midsole layer (120) and the lower midsole layer (125).


ML
HT
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110
111
112
113
112b
103
111b
131
130
111a
112a
120
102
121

Fig. 1

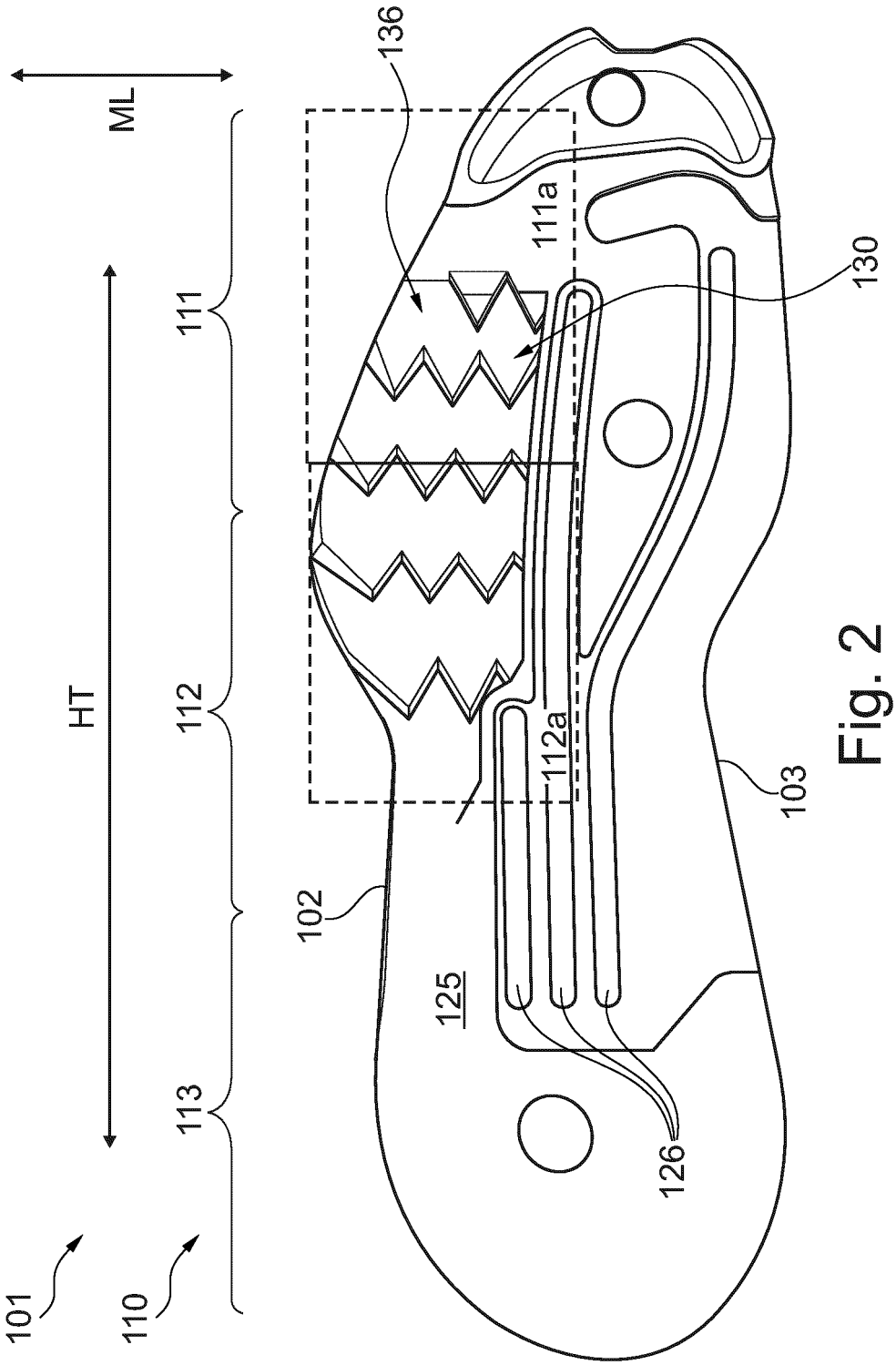


Fig. 2

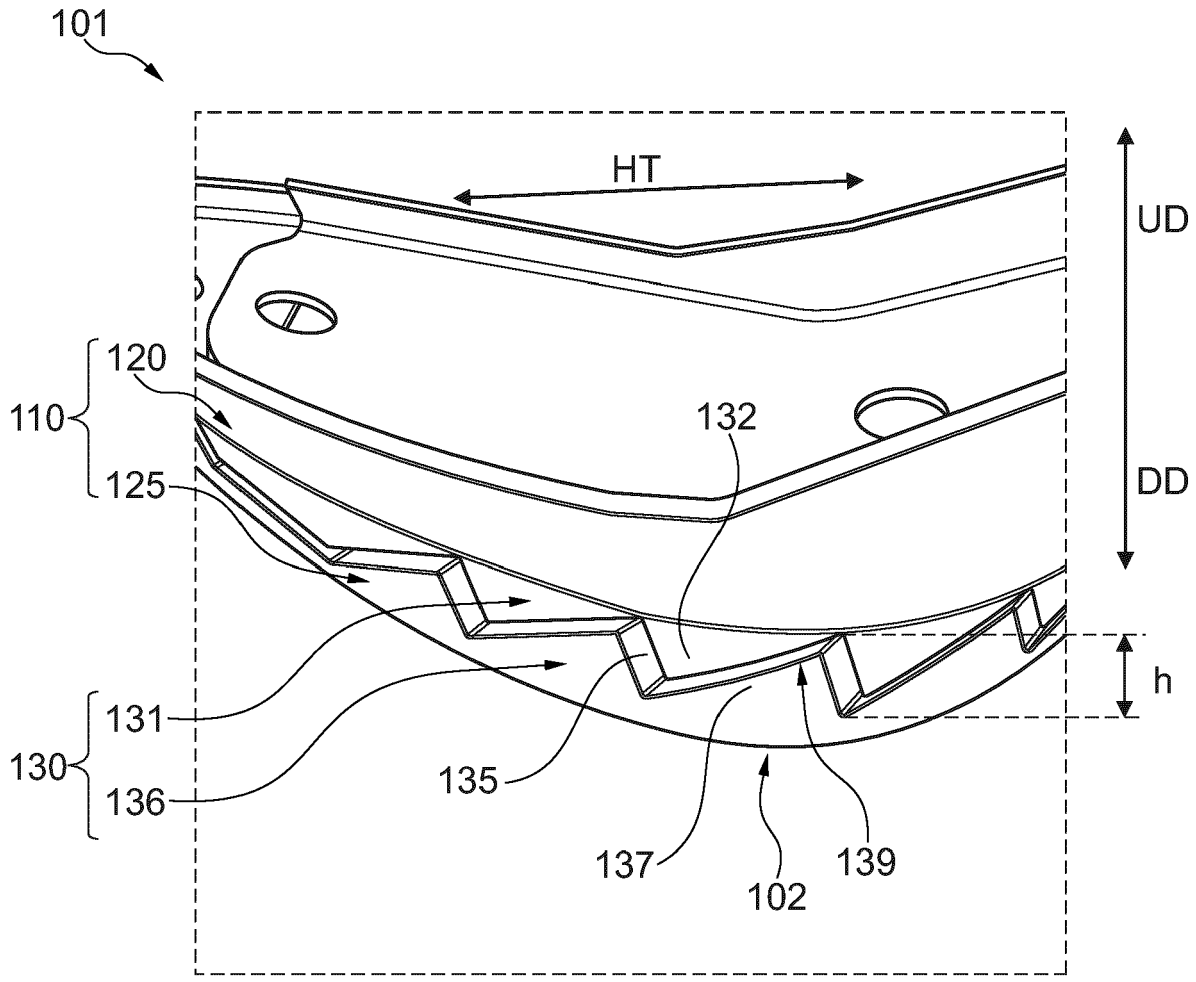
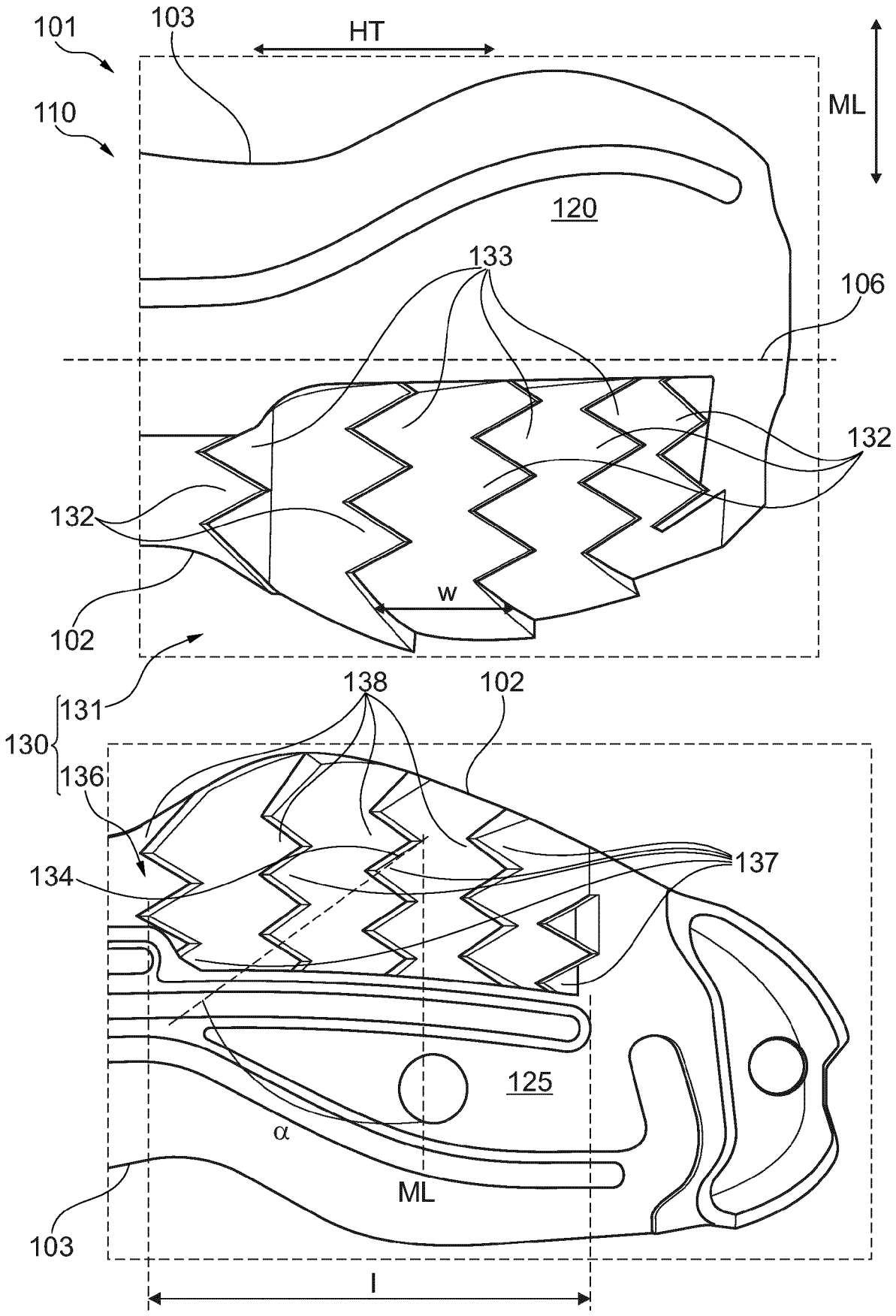


Fig. 3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HT
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ML
120
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130
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136
134
137
125
α
ML
103
l

Fig. 4

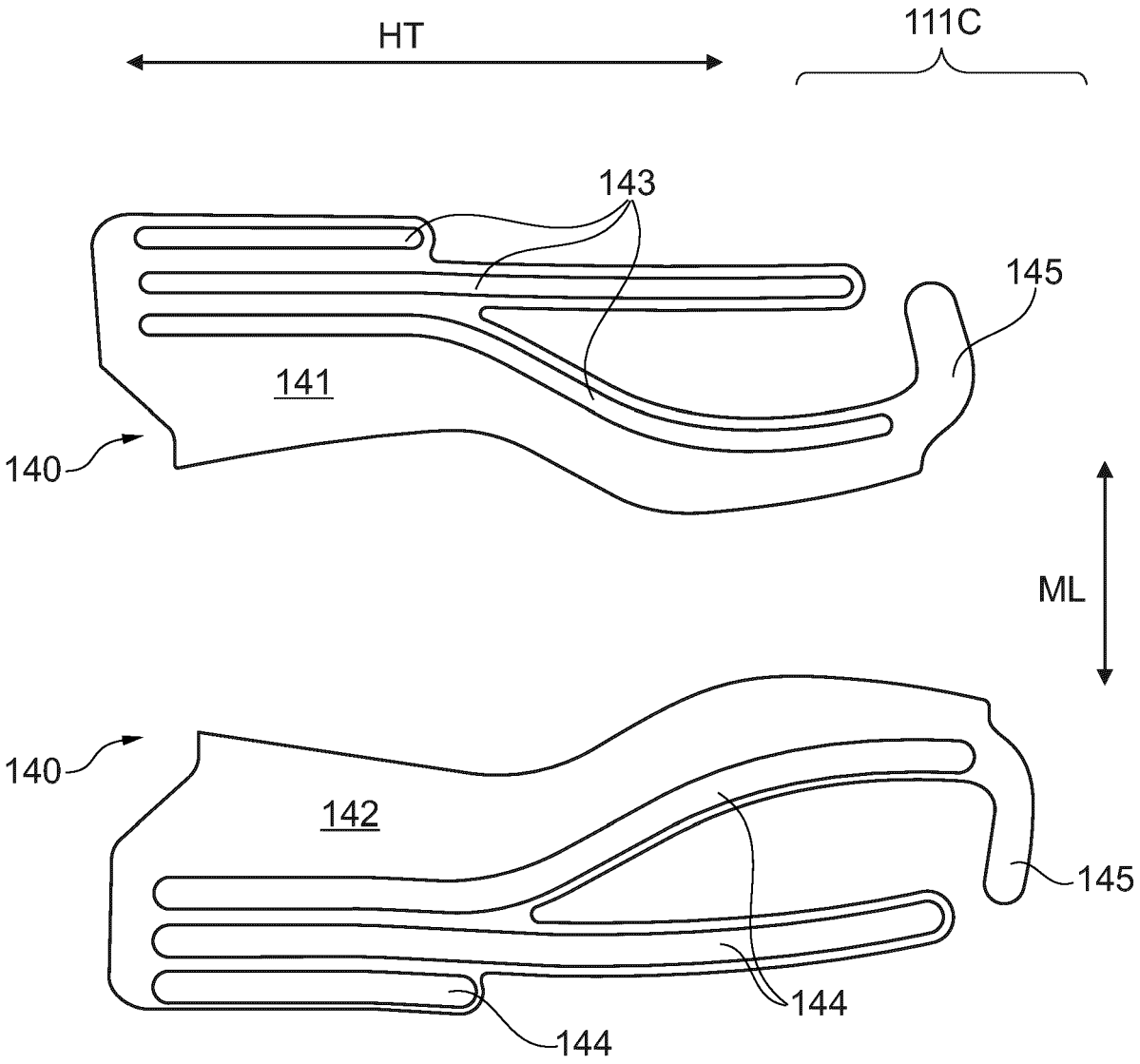


Fig. 5

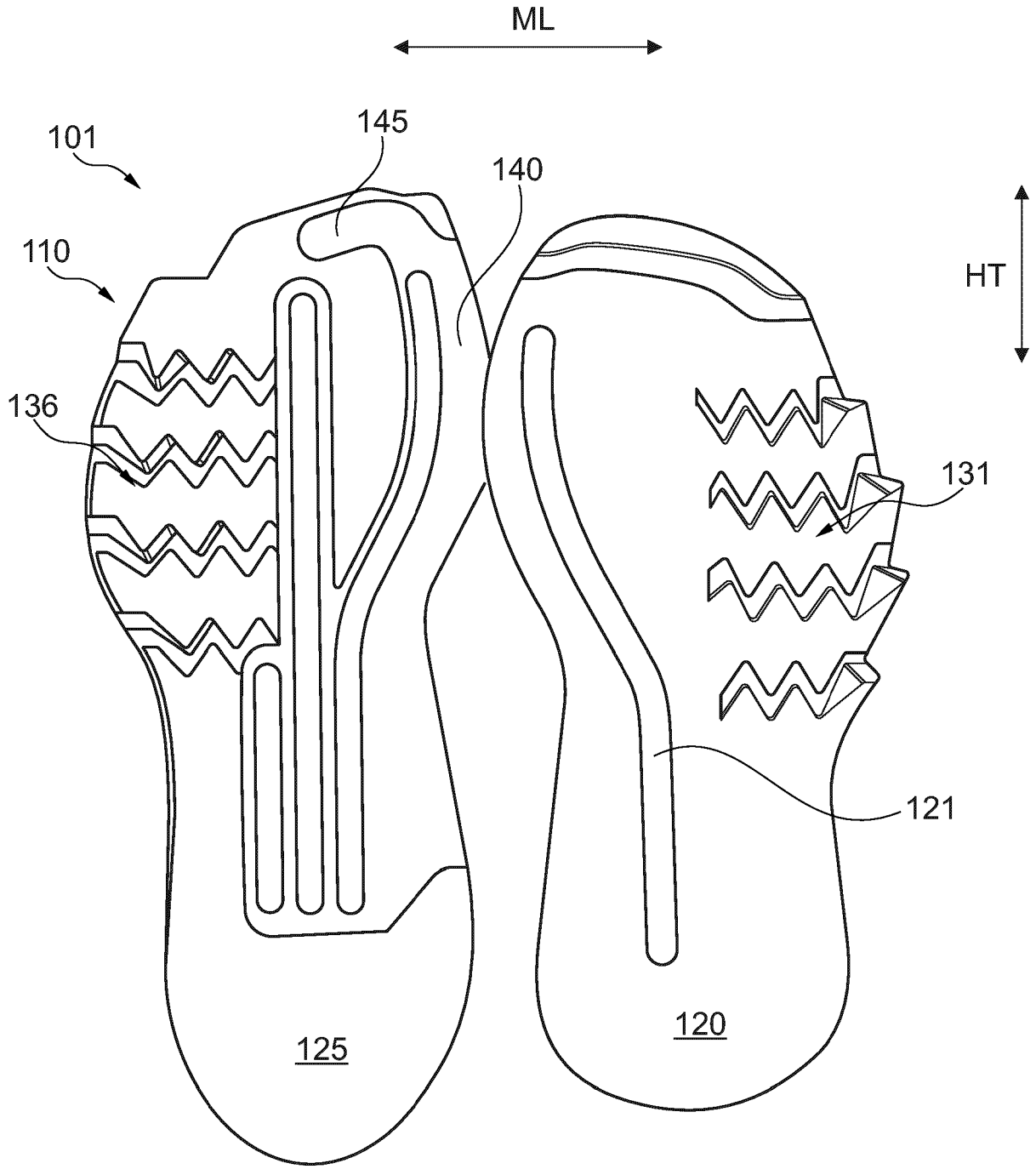
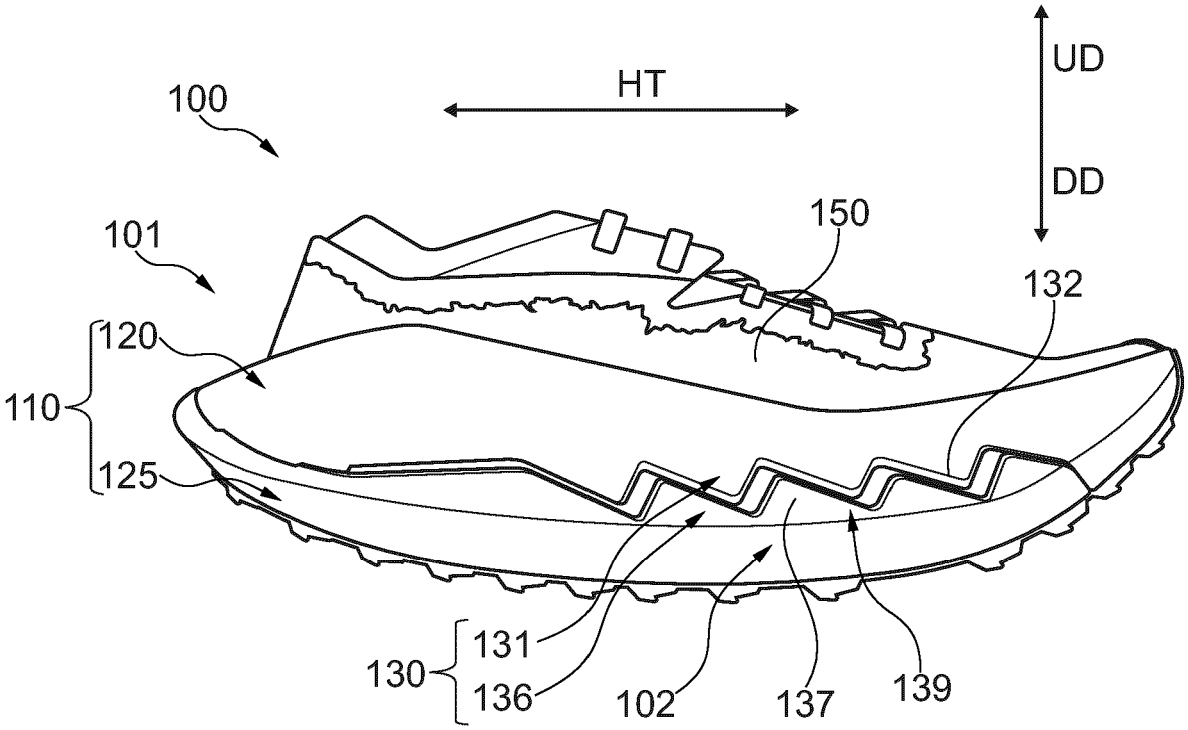


Fig. 6


UD
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DD
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150
101
132
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110
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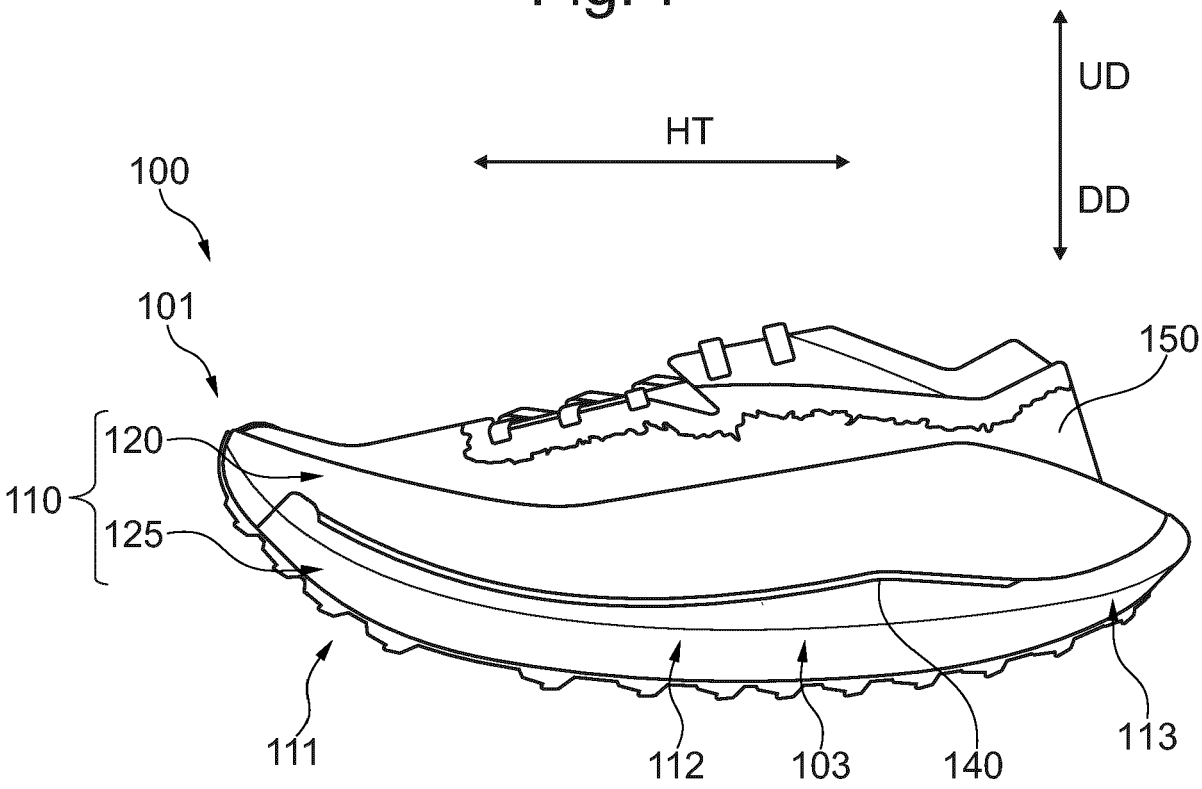
131
130
136
102
137
139

Fig. 7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140
113

Fig.7a

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EUROPEAN SEARCH REPORT

Application Number
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A43B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	3 March 2025	Ariza De Miguel, Jon

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