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(54) MICROFLUIDIC CHIP

(57) The present invention relates to a microfluidic chip. The microfluidic chip comprises a chip main body and a liquid sac storage piece; a liquid inlet is provided on the chip main body; the liquid sac storage piece is disposed on the chip main body, and a liquid sac cavity used for placing a liquid sac is disposed on the liquid sac storage piece; the liquid sac cavity is provided with a liquid outlet, the liquid outlet communicating with the liquid inlet; and a piercing piece is disposed in the liquid sac cavity; when the liquid sac is placed in the liquid sac cavity, there is a space between the liquid sac and the piercing piece; when the pressing force exerted on the liquid sac exceeds a preset value, the piecing piece can pierce the liquid sac. The described microfluidic chip can reduce the rejection rate of the chip, and improve the test repeatability and stability of the chip.

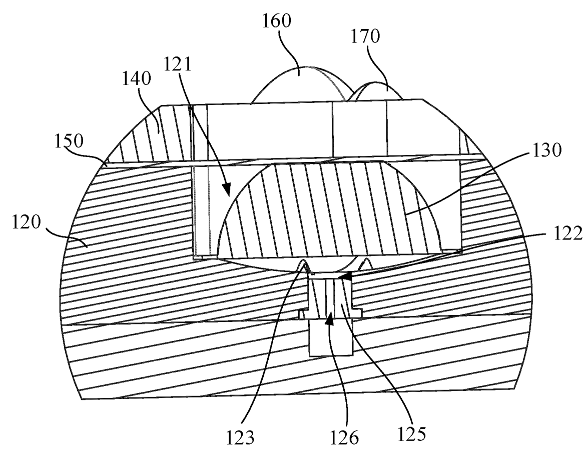

FIG. 5

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Description

TECHNICAL FIELD

[0001] The present invention relates to the technical field of microfluidics, particularly to a microfluidic chip.

BACKGROUND

[0002] POCT, i.e., point-of-care testing, is a detection mode that is carried out at the sampling site and uses portable analytical instruments and supporting reagents to quickly obtain results. POCT performs immediate analysis at the sampling site, simplifying the complicated processing procedures of specimens in laboratory test, thus has advantages of quickly getting results and simple to use.

[0003] At present, POCT products mainly include microfluidic chips and reagents for detection applied on microfluidic chips. The reagent storage modes of POCT products are divided into internal chip storage and external chip storage. Internal chip storage means that a reagent perfusion step is introduced in the process of chip processing and assembly, where liquid reagents are injected directly into the storage cavity or storage tank within the chip prior to completing the overall package of the chip. During internal chip storage, an additional separate packing for reagent storage is not required, and the reagent is directly accommodated inside the chip, which in turn requires blocking or valve control between the chip storage tank and the fluid channel inside the chip, otherwise the reagent may flow into the channel in advance during storage and transportation, resulting in scrap. In addition, combining reagent package and chip processing increases difficulties of processing and process controlling, and the process is lengthy and complicated. As an example, setting valve control or blocking increases the complexity of chip design, which not only requires to take the stability during reagent storage and transportation into account, but also requires to ensure the introduction of the reagent during testing, and the complexity of controlling the test system is also increased. Furthermore, in general, when employed internal chip storage, the type of reagents stored is limited, and the accommodation of multi-component reagents is not compatible.

[0004] External chip storage means that the chip assembly is independent from reagent filling and encapsulation processes, after the liquid reagent is sealed into a liquid bladder, the liquid bladder is fitted to corresponding position of the chip and assembled for use. During external chip storage, the reagent filling and encapsulation are separated from the chip processing and assembling steps. Therefore, the process control is more reliable, the storage of multiple types of reagents can be easily achieved, and has high flexibility and freedom degree when combining with the chip. However, the liquid bladder containing liquid reagents is fixed outside the chip, which is prone to be damaged by extrusion and thus scrapped during transportation and storage, and the test repeatability and stability are poor in use.

SUMMARY

[0005] Accordingly, it is necessary to provide a microfluidic chip that is capable of reducing scrap rate, improving test repeatability and stability.

[0006] A microfluidic chip includes:

> a chip body provided with a liquid inlet opening; and a liquid bladder storage member provided on the chip body. The liquid bladder storage member is provided with a liquid bladder cavity configured to accommodate a liquid bladder. The liquid bladder cavity is provided with a liquid outlet opening in communication with the liquid inlet opening. The liquid bladder cavity is provided with a spike member. When the liquid bladder is accommodated in the liquid bladder cavity, a spacing is formed between the liquid bladder and the spike member. When the liquid bladder is subjected to an extrusion force exceeding a preset value, the spike member is capable of piercing the liquid bladder.

[0007] In the aforementioned microfluidic chip, when the liquid bladder is accommodated in the liquid bladder cavity, the spacing is formed between the liquid bladder and the spike member, such that the liquid bladder will not be pierced when subjected to an extrusion force (for example, an extrusion force subjected during transportation and storage) not exceeding the preset value, and can be pierced when the applied extrusion force exceeds the preset value during use, thereby reducing the scrap rate of the aforementioned microfluidic chip. In addition, by providing the spike member, the flow rate and the flow resistance of the reagent flowing out of the liquid bladder can be substantially the same, thereby improving the detection repeatability and stability of the aforementioned microfluidic chip.

[0008] In one of embodiments, the spike member is provided with a liquid guiding groove in communication with the liquid outlet opening.

[0009] In one of embodiments, the spike member is shaped as a cone or a needle.

[0010] In one of embodiments, the microfluidic chip further includes a protecting member connected to the chip body and covering the liquid bladder storage member, and the protecting member is provided with a liquid bladder avoidance hole corresponding to the liquid bladder cavity.

[0011] In one of embodiments, the microfluidic chip further includes an indicating member located between the liquid bladder storage member and the protecting member. The indicating member is made of a material prone to be deformed by a force. The protecting member is a transparent protecting member, and/or both the liquid bladder storage member and the chip body are made of transparent materials.

[0012] In one of embodiments, the indicating member is made of plastic film, aluminum foil, tin foil, or paper.

[0013] In one of embodiments, the microfluidic chip further includes a first fixing member configured to fixedly connect the liquid bladder storage member and the chip body.

[0014] In one of embodiments, the microfluidic chip further includes a second fixing member configured to fixedly connect the protecting member and the liquid bladder storage member.

[0015] In one of embodiments, the microfluidic chip further includes a sealing member located between the liquid bladder storage member and the chip body. The sealing member is configured to seal a gap between the liquid bladder storage member and the chip body. The sealing member has a liquid channel, and the liquid outlet opening is in communication with the liquid inlet opening through the liquid channel.

[0016] In one of embodiments, a microfluidic chip is provided. A bottom of the liquid bladder cavity is shaped as a funnel, and the spike member is located on the bottom. The liquid outlet opening is located on the bottom at a position closest to the chip body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

FIG. 1 is a perspective view of a microfluidic chip according to an embodiment.

FIG. 2 is an exploded view of the microfluidic chip shown in FIG. 1.

FIG. 3 is a perspective view of a liquid bladder storage member of the microfluidic chip shown in FIG. 1.

FIG. 4 is a cross-sectional view of the microfluidic chip shown in FIG. 1.

FIG. 5 is an enlarged view of portion B of the liquid bladder storage member shown in FIG. 4.

FIG. 6 is an enlarged view of portion A of the liquid bladder storage member shown in FIG. 3.

FIG. 7 is an exploded view of the microfluidic chip shown in FIG. 1 before it is assembled.

Reference Numerals:

[0018] 10, microfluidic chip; 110, chip body; 120, liquid bladder storage member; 111, liquid inlet opening; 121, liquid bladder cavity; 122, liquid outlet opening; 123, spike member; 124, liquid guiding groove; 125, sealing member; 126, liquid channel; 130, liquid bladder; 140, protecting member; 141, avoidance hole; 150, indicating member; 160, first fixing member; 170, second fixing member; 180, positioning hole; 161, first fixing column; 171, second fixing column.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0019] In order to facilitate the understanding of the present application, the present application will be described more fully hereinafter. The present application may be embodied in many different forms and should not be limited to the embodiments described herein. Rather, the purpose of providing these embodiments is to make the present application more thorough and comprehensive.

[0020] It should be noted that when an element is referred to be "fixed to" another element, it can be directly fixed to another element, or there may be one or more mediating elements therebetween. When an element is referred to be "connected to" another element, it can be directly connected to another element, or there may be one or more mediating elements therebetween. When the terms "vertical", "horizontal", "left", "right", "up", "down", "inside", "outside", "bottom", and the like are used to indicate orientation or position relationships, they are orientation or position relationships shown based on the accompany drawings, and are merely for convenience of description, rather than indicating or implying that the indicated device or element should has a particular orientation or being constructed and operated in a particular orientation, thus should not to be construed as limitation of the present application. In addition, the terms "first" and "second" are only used for descriptive purposes, and cannot be understood as indicating or implying relative importance.

[0021] All technical and scientific terms used herein have the same meaning as commonly understood by skilled person in the art to which the present application belongs, unless otherwise defined. The terms used in the specification of the present application herein are for the purpose of describing specific embodiments only and are not intended to limit the present application.

[0022] Referring to FIGS. 1 and 2, a microfluidic chip 10 is provided according to one embodiment of the present application. The microfluidic chip 10 includes a chip body 110 and a liquid bladder storage member 120. The chip body 110 is provided with a liquid inlet opening 111. The liquid bladder storage member 120 is provided on the chip body 110. The liquid bladder storage member 120 is provided with a liquid bladder cavity 121 configured to accommodate a liquid bladder 130. The liquid bladder cavity 121 is provided with a liquid outlet opening 122 in communication with the liquid inlet opening 111. The liquid bladder cavity 121 is provided with a spike member 123. When the liquid bladder 130 is accommodated in the liquid bladder cavity 121, a spacing is formed between the liquid bladder 130 and the spike member 123. When the liquid bladder 130 is subjected to an extrusion force exceeding a preset value, the spike member 123 is capable of piercing the liquid bladder 130. When the liquid bladder 130 is accommodated in the liquid bladder cavity 121, the spacing is formed between the liquid bladder 130 and the spike member 123, such that the liquid bladder 130 will not be pierced by the spike member 123 when subjected to an extrusion force (for example, an extrusion force subjected during transportation and storage) not exceeding the preset value, and can be pierced by the spike member 123 when the applied extrusion force exceeds the preset value during use, thereby reducing the scrap rate of the aforementioned microfluidic chip 10. In addition, the rupture of the liquid bladder in conventional microfluidic chips is caused by rupture of aluminum foil on the side of the liquid bladder close to the liquid outlet opening due to directly squeezing the liquid bladder, thus the liquid flows out. It has been found by the research of the present application that such manner makes a large randomness of the rupture of the liquid bladder, and is easy to result in a large difference in the flow rate and the flow resistance of the liquid reagent when entering the chip body, thereby affecting the test reproducibility and stability. Therefore, in the present application, by providing the spike member 123, after the liquid bladders 130 are subjected to the same extrusion force (or different extrusion forces greater than a limit value of piercing the liquid bladder 130, as the extrusion force will not change the size of the opening of the liquid bladder 130 after exceeding the limit value, and thus will not affect the flow rate and the flow resistance), openings of the plurality of the liquid bladders 130 are substantially the same, such that the flow rate and the flow resistance of the reagent flowing out of each liquid bladder 130 are substantially the same, thereby improving the detection repeatability and stability of the aforementioned microfluidic chip 10.

[0023] Specifically, when the liquid bladder 130 is pierced by the spike member 123, the preset value of the extrusion force to which the liquid bladder 130 is subjected is related to the material of the liquid bladder 130, the spacing distance between the liquid bladder 130 and the spike member 123 when the liquid bladder 130 is accommodated in the liquid bladder cavity 121, and the extrusion force to which the liquid bladder 130 is subjected during transportation and storage. The specific preset value may be determined according to the material of the liquid bladder 130, the spacing distance between the liquid bladder 130 and the spike member 123 when the liquid bladder 130 is accommodated in the liquid bladder cavity 121, and the extrusion force to which the liquid bladder 130 is subjected during transportation and storage. It should be understood that the preset value of the extrusion force is designed based on the actual force to which the liquid bladder 130 is subjected in a direction from the liquid bladder 130 towards the piercing member 123. For example, in the illustrated embodiments, the preset value of the extrusion force is designed based on a vertical-downward force that the liquid bladder 130 can withstand. For example, if the liquid bladder 130 is subjected to an obliquely downward force, the force in the vertical direction is just a partial force of the obliquely downward force, and the liquid bladder 130 will not be pierced as long as the partial force does not exceed the preset value.

[0024] In some embodiments, a side of the liquid bladder 130 adjacent to the spike member 123 is made of aluminum foil, PET film, PP film, or LDPE film. In some other embodiments, the side of the liquid bladder 130 adjacent to the spike member 123 is made of a composite film of plastic film and aluminum foil. In some embodiments, the side of the liquid bladder 130 adjacent to the spike member 123 has a thickness ranging from 50 μm to 200 μm. A side of the liquid bladder 130 away from the spike member 123 is made of at least one of PP, HDPE, PVC, and PET. The liquid bladder 130 with a dome shell structure is prepared from the aforementioned materials (at least one of PP, HDPE, PVC, and PET) by a blow or injection molding process. In some other embodiments, the side of the liquid bladder 130 away from the spike member 123 has a thickness ranging from 75 μm to 200 μm.

[0025] When the liquid bladder 130 is accommodated in the liquid bladder cavity 121, a distance of the spacing between the liquid bladder 130 and the spike member 123 ranges from 1 mm to 10 mm, e.g., 2 mm, 5 mm, or 8 mm. The distance of the spacing between the liquid bladder 130 and the spike member 123 refers to a distance from a position of the spike member 123 closest to the liquid bladder 130 to the side of the liquid bladder 130 close to the spike member 123. It should be understood that when the liquid bladder 130 is accommodated in the liquid bladder cavity 121, the distance of the spacing between the liquid bladder 130 and the spike member 123 can be adjusted according to the material of the liquid bladder 130. If the liquid bladder 130 is made of a material prone to be deformed by extrusion and thus prone to approach the spike member 123, the distance of the spacing between the liquid bladder 130 and the spike member 123 can be greater. If the liquid bladder 130 is made of a material that is not easily deformed by extrusion and thus does not easily approach the spike member 123, then the distance of the spacing between the liquid bladder 130 and the spike member 123 can be less. As such, the aforementioned microfluidic chip 10 is not easy to scrap during transportation and storage, and is easy to be pierced in use.

[0026] Specifically, as an important component of the POCT product, the chip body 110 includes a reaction chamber and a fluid channel in communication with the reaction chamber. The chip body 110 is provided with the liquid inlet opening 111, which is in communication with the reaction chamber on the chip body 110. During detection, the reagent for detection enters the chip body 110 from the liquid inlet opening 111.

[0027] In some embodiments, the chip body 110 is provided with a plurality of reaction chambers in communication with each other through the fluid channel. At least some of the reaction chambers have respective liquid inlet openings 111, in which case the liquid bladder storage member 120 is provided with the liquid bladder cavities 121 and the liquid outlet openings 122 corresponding to these reaction chambers. In the illustrated embodiments, the chip body 110 is provided with six spaced liquid inlet openings 111, and the liquid bladder storage member 120 is provided with six liquid bladder cavities 121 and six liquid outlet openings 122. In the illustrated embodiments, one liquid bladder cavity 121 corresponds to one liquid outlet opening 122, and one liquid outlet opening 122 corresponds to one liquid inlet opening 111. It should be understood that in other embodiments, one liquid bladder cavity 121 can correspond to multiple liquid outlet openings 122. Multiple or one liquid outlet opening 122 may correspond to one or more liquid inlet openings 111. The number of the liquid inlet opening 111 and the liquid outlet opening 122 can be adjusted according to actual conditions. Of course, in some embodiments, there may be only one reaction chamber on the chip. In this case, the number of the liquid bladder 121 on the liquid bladder storage member 120 is one. It should be understood that the sizes of the liquid inlet opening 111 and the liquid outlet opening 122 are not particularly limited, and can be adjusted according to actual conditions (for example, the flow rate or flow of the liquid reagent).

[0028] In the illustrated embodiments, the chip body 110 is shaped as a disc. It should be understood that in other embodiments, the chip body 110 is not limited to be shaped as a disc, but may also as any other shape. For example, it may be shaped as a square or an oval. In some embodiments, the material of the chip body 110 is at least one selected from the group consisting of polydimethylsiloxane (PDMS), polyurethane, epoxy resin, polymethyl methacrylate (PMMA), polycarbonate (PC), cycloolefin copolymer (COC/COP), polystyrene (PS), polyethylene (PE), polypropylene (PP), and fluoroplastic. It should be understood that the material of the chip body 110 is not limited to the above, but may also be other materials.

[0029] Referring to FIGS. 3 to 5, the liquid bladder storage member 120 is configured to store the liquid bladder 130 containing the liquid reagent. Specifically, the liquid bladder storage member 120 is provided with the liquid bladder cavity 121 configured to accommodate the liquid bladder 130. In the illustrated embodiments, the liquid bladder storage member 120 is shaped as a disc. It should be understood that in other embodiments, the liquid bladder storage member 120 is not limited to be shaped as the above, but can also be adjusted according to actual requirements. In the illustrated embodiments, six liquid bladder cavities 121 are provided. It should be understood that in other embodiments, the number of the liquid bladder storage member 121 is not limited to the above, but can also be adjusted according to actual conditions. Of course, the shape of the liquid bladder cavity 121 is not limited, but is required to match the liquid bladder 130. For example, in the illustrated embodiments, the liquid bladder 130 is substantially shaped as a hemisphere, and the liquid bladder cavity 121 is substantially shaped as a column with a bottom recessed towards the chip body 110.

[0030] In some embodiments, the liquid bladder storage member 120 is made of rigid materials. By employing the rigid liquid bladder storage member 120, the liquid bladder 130 in the liquid bladder cavity 121 can be protected.

[0031] In some embodiments, the bottom of the liquid bladder cavity 121 is shaped as a funnel, and the spike member 123 is located on the bottom. The liquid outlet opening 122 is located on the bottom at a position closest to the chip body 110. By configuring the shape of the bottom of the liquid bladder cavity 121 as a funnel, the spacing is formed between the spike member 123 and the liquid bladder 130. Therefore, the liquid bladder 130 is required to be subjected to a certain amount of extrusion force to be pierced by the spike member 123, rather than being pierced when subjected to just a slight extrusion, which reduces the scrap rate of the aforementioned chip. In addition, the funnel-shaped bottom of the liquid bladder 130 further facilitates the flow of the liquid reagent in the liquid bladder 130 towards the chip body 110 without wasting the liquid reagent easily. It should be understood that in other embodiments, the bottom of the liquid bladder cavity 121 is not limited to be shaped as a funnel, but may also as other curved surfaces recessed towards the chip body 110.

[0032] In some embodiments, the spike member 123 is shaped as a cone or a needle. In one optional specific example, the spike member 123 is shaped as a circular cone or a triangular pyramid. After a sealing film of the liquid bladder 130 is pierced by the spike member 123, the opening of the sealing film pierced increases with the increasing of the piercing depth. In some embodiments, a plurality of spike members 123 are provided, which are spaced apart surrounding the liquid outlet opening 122. Furthermore, the distances between the plurality of spike members 123 and the center of the liquid outlet opening 122 are equal. In the illustrated embodiments, three spike members 123 are provided, the three spike members 123 are spaced apart surrounding the liquid outlet opening 122, and the distances between the three spike members 123 and the center of the liquid outlet opening 122 are equal. It should be understood that in other embodiments, the number of the spike member 123 is not limited to be three as described above, but may also be other, such as one, two, five, or six.

[0033] Referring to FIG. 6, in some embodiments, the spike member 123 is further provided with a liquid guiding groove 124. The liquid guiding groove 124 is in communication with the liquid outlet opening 122. The liquid guiding groove 124 is configured to guide the liquid in the liquid bladder 130 to the liquid outlet opening 122. In the illustrated embodiments, the liquid guiding groove 124 is provided on a side of the spike member 123 adjacent to the liquid outlet opening 122. It should be understood that in other embodiments, the liquid guiding groove 124 is not limited to be provided at the above position, but may also at other positions on the spike member 123. For example, the liquid guiding groove 124 is provided on a side of the spike member 123 away from the liquid outlet opening 122.

[0034] Referring to FIG. 5, in some embodiments, the aforementioned chip 10 further includes a sealing member 125. The sealing member 125 is located between the liquid bladder storage member 120 and the chip body 110, and is configured to seal a gap therebetween. The sealing member 125 has a liquid channel 126, and the liquid outlet opening 122 is in communication with the liquid inlet opening 111 through the liquid channel 126. Specifically, the liquid bladder storage member 120 has a liquid outlet channel, one end of the liquid outlet channel is in communication with the liquid outlet opening 122, and the other end thereof is in communication with the liquid inlet opening 111. The sealing member 125 is located in the liquid outlet channel. An outer side wall of the sealing member 125 is sealed and connected to a side wall of the liquid outlet channel, and an outer wall of the sealing member 125 adjacent to the chip body 110 is sealed and connected to the chip body 110. In this case, the liquid reagent flows out of the liquid outlet opening 122 and enters the liquid inlet opening 111 through the liquid channel 126. Optionally, the sealing member 125 is an elastic sealing member 125. In one optional specific example, the sealing member 125 is made of TPU, silicone rubber, rubber, or resin. It should be understood that the sealing member 125 is not limited to be made of the above, but may also be other materials used for sealing.

[0035] It should be understood that in some embodiments, the sealing member 125 can be omitted. In this case, the gap between the liquid bladder storage member 120 and the chip body 110 that is not configured for the liquid reagent to flow into the chip body 110 may be sealed by other means. For example, the gap between the liquid bladder storage member 120 and the chip body 110 that is not configured for the liquid reagent to flow into the chip body 110 may be sealed by a sealant.

[0036] In some embodiments, the aforementioned microfluidic chip 10 further includes the liquid bladder 130. The liquid bladder 130 is configured to carry the liquid reagent. The liquid reagent includes but not limited to at least one of buffer solution (ionic solution, surfactant mixture), reaction solution (antigen/antibody dilution, protein dilution, magnetic particle dilution, luminescent/fluorescent reagent dilution, nucleic acid dilution, molecule/protein bio-probe dilution, etc.), and cleaning solution (surfactant mixture, decontaminant, etc.). In the illustrated embodiments, six liquid bladders 130 are provided. It should be understood that in other embodiments, the number of the liquid bladder 130 is not limited to the above, but can also be adjusted according to actual conditions.

[0037] In some embodiments, the microfluidic chip 10 includes a protecting member 140. The protecting member 140 is configured to reduce extrusion to the liquid bladder 130 by an external force during transportation and/or storage process, which can avoid the aforementioned microfluidic chip 10 from scrapping caused by the liquid bladder 130 being pierced in advance due to extrusion to the liquid bladder 130 by the external force during transportation and/or storage process, thus further reducing the scrap rate of the aforementioned microfluidic chip 10. The protecting member 140 covers a side of the liquid bladder storage member 120 away from the chip body 110 and is fixedly connected to the chip body 110. The protecting member 140 is provided with an avoidance hole 141 corresponding to the liquid bladder cavity 121. The number of the avoidance hole 141 corresponds to the number of the liquid bladder 130. In the illustrated embodiments, six avoidance holes 141 are provided. When using the aforementioned microfluidic chip 10, the liquid bladder 130 is squeezed through the avoidance hole 141, such that the liquid bladder 130 can be contact with the spike member 123 and thus be pierced. The manner of fixed connection used herein is not particularly limited, unless specifically indicated. For example, the fixed connection may be removable fixed connection such as screw connection or snap connection, or non-removable fixed connection such as bonding, welding, riveting, interference fitting, or the like.

[0038] In the illustrated embodiments, the protecting member 140 is shaped as a disc. It should be understood that in other embodiments, the protecting member 140 is not limited to be shaped as the above, but can also be adjusted according to actual conditions.

[0039] In the illustrated embodiments, the avoidance hole 141 is a through hole provided in an axial direction of the protecting member 140. A force is applied in the axial direction of the protecting member 140 through the avoidance hole 141 and the liquid bladder 130 is squeezed, such that the liquid bladder 130 gets close to the spike member 123 and is then pierced by the spike member 123. It should be understood that in other embodiments, the avoidance hole 141 may also be provided in a radial direction of the protecting member 140. In this case, a force is applied in the axial direction of the protecting member 140 through the avoidance hole 141 in the radical direction and the liquid bladder 130 is squeezed, such that the liquid bladder 130 gets close to the spike member 123 and is then pierced by the spike member 123.

[0040] In some embodiments, the microfluidic chip 10 further includes an indicating member 150. The indicating member 150 is configured to indicate whether the liquid bladder 130 is broken or has been subjected to an external force. Specifically, the indicating member 150 is located between the liquid bladder storage member 120 and the protecting member 140, and is made of a material prone to be deformed by a force. In this case, the protecting member 140 is a transparent protecting member 140, and/or both the liquid bladder storage member 120 and the chip body 110 are made of transparent materials. The components located on (the protecting member 140) and under (the liquid bladder storage member 120 and the chip body 110) the indicating member 150 are made of transparent materials, which facilitates observation of whether the indicating member 150 is broken or deformed from above or below the indicating member 150, thereby determining whether the liquid bladder 130 is squeezed by an external force and is broken. On the other hand, whether the test is completed can also be confirmed through the indicating member 150. For example, during assembly, the indicating member 150 is placed above the reagents that have completed the test, and there is no indicating member 150 on the reagents that have not participated in the test.

[0041] Optionally, the indicating member 150 is made of plastic film, aluminum foil, tin foil, or paper. In one optional specific example, the indicating member 150 is made of at least one of polyester film (PET), polypropylene film (PP), and polyethylene film (PE). In another optional specific example, the indicating member 150 is made of one of soft/rigid label paper with a dashed indentation, printing paper, and laminated paper. It should be understood that the indicating member 150 is not limited to be made of the above materials, and can also be made of other materials prone to be deformed by a force.

[0042] In some embodiments, the aforementioned microfluidic chip 10 further includes a first fixing member 160, and the liquid bladder storage member 120 is fixedly connected to the chip body 110 through the first fixing member 160. In the illustrated embodiments, the first fixing member 160 extends through the protecting member 140, the indicating member 150, and the liquid bladder storage member 120, and is configured to fixedly connect the protecting member 140, the indicating member 150 and the liquid bladder storage member 120 to the chip body 110. It should be understood that the protecting member 140 and the indicating member 150 may be fixedly connected to the liquid bladder storage member 120 through the first fixing member 160, or may by other means. Optionally, the first fixing member 160 is made of thermoplastic materials. The employment of thermoplastic materials can make it easier to organize the aforementioned microfluidic chip 10. In the illustrated embodiments, the microfluidic chip 10 further includes a second fixing member 170, the protecting member 140 and the indicating member 150 are fixedly connected to the liquid bladder storage member 120 through the second fixing member 170. Specifically, the second fixing member 170 extends through the protecting member 140 and the indicating member 150, and is fixedly connected to the liquid bladder storage member 120.

[0043] In some embodiments, the aforementioned microfluidic chip 10 further includes a positioning hole 180. During assembly or use of the aforementioned microfluidic chip 10, the positioning hole 180 is configured for positioning, which facilitates the assembly and use.

[0044] In some embodiments, the aforementioned microfluidic chip 10 includes the chip body 110 and the liquid bladder storage member 120 provided on the chip body 110. In other words, in this case, the microfluidic chip 10 is a microfluidic chip 10 capable of loading the liquid bladder 130 formed by assembling the chip body 110 and the liquid bladder storage member 120. The liquid bladder 130 can be freely selected according to specific requirements and then assembled with the microfluidic chip 10 that can load the liquid bladder 130, thereby forming a microfluidic chip 10 that can be used directly.

[0045] In some embodiments, the aforementioned microfluidic chip 10 includes the chip body 110, the liquid bladder storage member 120 provided on the chip body 110, the liquid bladder 130 provided in the liquid bladder storage member 120, and the protecting member 140 provided on the side of the liquid bladder storage member 120 away from the chip body 110. The chip body 110 is fixedly connected to the liquid bladder storage member 120 and the protecting member 140. In this case, the microfluidic chip 10 is the microfluidic chip 10 that can be used directly. In the illustrated embodiments, the aforementioned microfluidic chip 10 includes the chip body 110, the liquid bladder storage member 120 provided on the chip body 110, the liquid bladder 130 provided in the liquid bladder storage member 120, the protecting member 140 provided on the side of the liquid bladder storage member 120 away from the chip body 110, and the indicating member 150 located between the protecting member 140 and the liquid bladder storage member 120. The chip body 110, the liquid bladder storage member 120, the protecting member 140, and the indicating member 150 are fixedly connected through the first fixing member 160, and the liquid bladder storage member 120, the protecting member 140, and the indicating member 150 are further fixedly connected through the second fixing member 170.

[0046] In some embodiments, a thickness of the aforementioned microfluidic chip 10 ranges from 10 mm to 20 mm. The thickness of the microfluidic chip 10 herein refers to an axial length of the microfluidic chip 10, i.e., a distance from a side of the chip body 110 away from the liquid bladder storage member 120 to a side of the protecting member 140 away from the indicating member 150. Of course, if there is no protecting member 140 and indicating member 150, it refers to a distance from a side of the chip body 110 away from the liquid bladder storage member 120 to the side of the liquid bladder storage member 120 away from the chip body 110. It should be understood that the thickness of the aforementioned microfluidic chip 10 is not limited to the above, but can also be adjusted according to actual conditions.

[0047] The aforementioned microfluidic chip 10 has at least the following advantages:

(1) When the liquid bladder 130 is accommodated in the liquid bladder cavity 121 and is not used, a spacing is formed between the liquid bladder 130 and the spike member 123, such that the liquid bladder 130 will not be pierced when subjected to an extrusion force not exceeding the preset value (general extrusion force subjected during transportation and storage), while the liquid bladder 130 will be

pierced when subjected to an extrusion force exceeding the preset value, which reduces the scrap rate of the aforementioned microfluidic chip 10.

(2) By providing the spike member 123, after the liquid bladders 130 are subjected to the same extrusion force, openings of a plurality of the liquid bladders 130 are substantially the same, such that the flow rate and the flow resistance of the reagent flowing out of each liquid bladder 130 are substantially the same, thus the detection repeatability, stability, and consistency of the aforementioned microfluidic chip 10 can be improved, and the difference of the POCT test process can be reduced. In addition, reagent guiding drive may be completed by manual or external equipment mechanism, the operation is simple. The design of the liquid guiding groove 124 and the sealing member 125 greatly improves the liquid terminal utilization efficiency, and reduces the loss and dead volume of the liquid during the flow transferring process.

(3) A variety of bonding assembly processes with the chip are applicable. The assembly position is outside the functional reaction area of the chip, which does not affect the fluid design and reaction scheme design within the chip, only requiring an interface on the upper surface of the chip corresponding to the liquid inlet opening at the bottom of the device to achieve the introduction of the reagent. The modular design can match chips with different detection requirements and different structural designs.

(4) The design of the plurality of liquid bladder 130 and the adoption of different colors of liquid bladders 130 can distinguish different reagents, making the aforementioned microfluidic chip 10 widely used for detection and can be used as a modular chip. In addition, multiple reagents can be freely combined, the reagents are compatible with the cavity, and it is not easy to be confused when there are various types of reagents.

[0048] Referring to FIG. 7, an assembly method of the aforementioned microfluidic chip 10 is further provided according to one embodiment of the present application. The assembly method fixes the chip body 110, the liquid bladder storage member 120 accommodated with the liquid bladder 130, the indicating member 150, and the protecting member 140 by riveting, and the aforementioned microfluidic chip 10 is prepared. Specifically, the assembly method includes step S100 and step S200. Specifically:

Step S100: the liquid bladder storage member 120 is provided on a first fixing column 161 on the chip body 110, and the gap between the liquid outlet opening 122 and the liquid inlet opening 111 is sealed by the sealing member 125. The first fixing column 161 is fixed on a surface of the chip body 110 provided with the liquid inlet opening 111.

Step S200: the liquid bladder 130 is accommodated in the liquid bladder cavity 121 of the liquid bladder storage member 120, and then the indicating member 150 and the protecting member 140 are successively sleeved on a second fixing column 171 on the indicating member 150 and the first fixing column 161 on the chip body 110. The chip body 110, the liquid bladder storage member 120, the indicating member 150, and the protecting member 140 are fixed by riveting.

[0049] In one of embodiments, the riveting is a combination of hot air and cold riveting. Specifically, both the first fixing column 161 and the second fixing column 171 are made of thermoplastic materials. Hot air and/or heats from the first fixing column 161 and one end of the second fixing column 171 close to the protecting member 140, when it is melted or softened, after the preset heating time, the first fixing column 161 and the second fixing column 171 are pressed down to form the rivet using a cold fixture, thus the chip body 110, the liquid bladder storage member 120, the indicating member 150, and the protecting member 140 are fixed.

[0050] In one of the embodiments, the riveting is ultrasonic riveting. Specifically, both the first fixing column 161 and the second fixing column 171 are made of thermoplastic materials. The fixing column and the second fixing column 171 are heated using ultrasonic highfrequency vibration, and a rivet is formed after melting by an ultrasonic indenter. Compared with other riveting manners, ultrasonic heating is very rapid and the period is short. Suitable rivet design is required to provide a relatively small initial contact between the ultrasonic indenter and the fixing column, to produce a rapid heating effect. During ultrasonic riveting, high amplitude vibration and decelerated descent of the ultrasonic indenter are used to melt and flow the studs, and the ultrasonic indenter is filled to form a rivet cap, such that the chip body 110 is fixed with the liquid bladder storage member 120, the indicating member 150, and the protecting member 140.

[0051] In one of the embodiments, the riveting is infrared or laser riveting. Specifically, similar to ultrasonic riveting, except that the first fixing column 161 and the second fixing column 171 are melted by infrared heating or laser heating.

[0052] In the assembly methods according to aforementioned embodiments, the chip body 110 is fixed with the liquid bladder storage member 120, the indicating member 150, and the protecting member 140 by riveting. In should be understood that in other embodiments, the chip body 110 is not limited to be fixed with the liquid bladder storage member 120, the indicating member 150, and the protecting member 140 by riveting, but may also by other means, such as adhesive, ultrasonic welding, laser welding, etc. The specific assembly process may be determined according to actual requirements of the microfluidic chip 10. For example, if the microfluidic chip 10 has limited pressure-bearing capacity due to its low thickness or structural design factors, then riveting is not appropriate, and adhesive or ultrasonic welding processes are more suitable. For another example, if the storage reagent itself is not resistant to high temperature, then riveting, ultrasonic, and laser welding processes are not suitable (the thermal effect is not controllable, which affects the stability and performance of the reagent, or even makes the reagent ineffective), in this case ambient temperature operation process such as adhesive process is more suitable.

[0053] The aforementioned assembly methods of the microfluidic chip 10 is convenient and simple to operate, facilitating industrial production.

[0054] Each of the technical features of the above-mentioned embodiments may be combined arbitrarily. To simplify the description, not all the possible combinations of each of the technical features in the above embodiments are described. However, all of the combinations of these technical features should be considered as within the scope of this application, as long as such combinations do not contradict with each other.

[0055] The aforementioned embodiments only illustrate several embodiments of the present application, which facilitate a specific and detailed understanding of the technical solutions of the present application, but they cannot be understood to limit the protection scope of the present application. It should be noted that a plurality of variations and modifications may be made by those skilled in the art without departing from the scope of the present application, which are all within the scope of protection of the present application. It should be understood that technical solutions obtained by those skilled in the art through logical analysis, reasoning or limited experiments on the basis of the technical solutions provided by the present application are all within the protection scope of the appended claims of the present application. Accordingly, the scope of protection of the present application shall be based on the appended claims, and the description and the accompany drawings may be used to interpret the content of the claims.

Claims

1. A microfluidic chip, comprising:

a chip body provided with a liquid inlet opening; and

a liquid bladder storage member provided on the chip body, wherein the liquid bladder storage member is provided with a liquid bladder cavity configured to accommodate a liquid bladder, the liquid bladder cavity is provided with a liquid outlet opening in communication with the liquid inlet opening, the liquid bladder cavity is provided with a spike member, when the liquid bladder is accommodated in the liquid bladder cavity, a spacing is formed between the liquid bladder and the spike member, when the liquid bladder is subjected to an extrusion force exceeding a preset value, the spike member is capable of piercing the liquid bladder.

2. The microfluidic chip according to claim 1, wherein the spike member is provided with a liquid guiding groove in communication with the liquid outlet opening.

3. The microfluidic chip according to claim 1, wherein the spike member is shaped as a cone or a needle.

4. The microfluidic chip according to any one of claims 1 to 3, further comprising a protecting member connected to the chip body and covering the liquid bladder storage member, wherein the protecting member is provided with a liquid bladder avoidance hole corresponding to the liquid bladder cavity.

5. The microfluidic chip according to claim 4, further comprising an indicating member located between the liquid bladder storage member and the protecting member, wherein the indicating member is made of a material prone to be deformed by a force, the protecting member is a transparent protecting member, and/or both the liquid bladder storage member and the chip body are made of transparent materials.

6. The microfluidic chip according to claim 5, wherein the indicating member is made of plastic film, aluminum foil, tin foil, or paper.

7. The microfluidic chip according to claim 1, further comprising a first fixing member configured to fixedly connect the liquid bladder storage member and the chip body.

8. The microfluidic chip according to any one of claims 5 to 7, further comprising a second fixing member configured to fixedly connect the protecting member and the liquid bladder storage member.

9. The microfluidic chip according to claim 4, further comprising a sealing member located between the liquid bladder storage member and the chip body, wherein the sealing member is configured to seal a gap between the liquid bladder storage member and the chip body, the sealing member has a liquid channel, and the liquid outlet opening is in communication with the liquid inlet opening through the liquid channel.

10. The microfluidic chip according to any one of claims 1 to 3, 5 to 7, and 9, wherein a bottom of the liquid bladder cavity is shaped as a funnel, the spike member is located on the bottom, and the liquid outlet opening is located on the bottom at a position closest to the chip body.

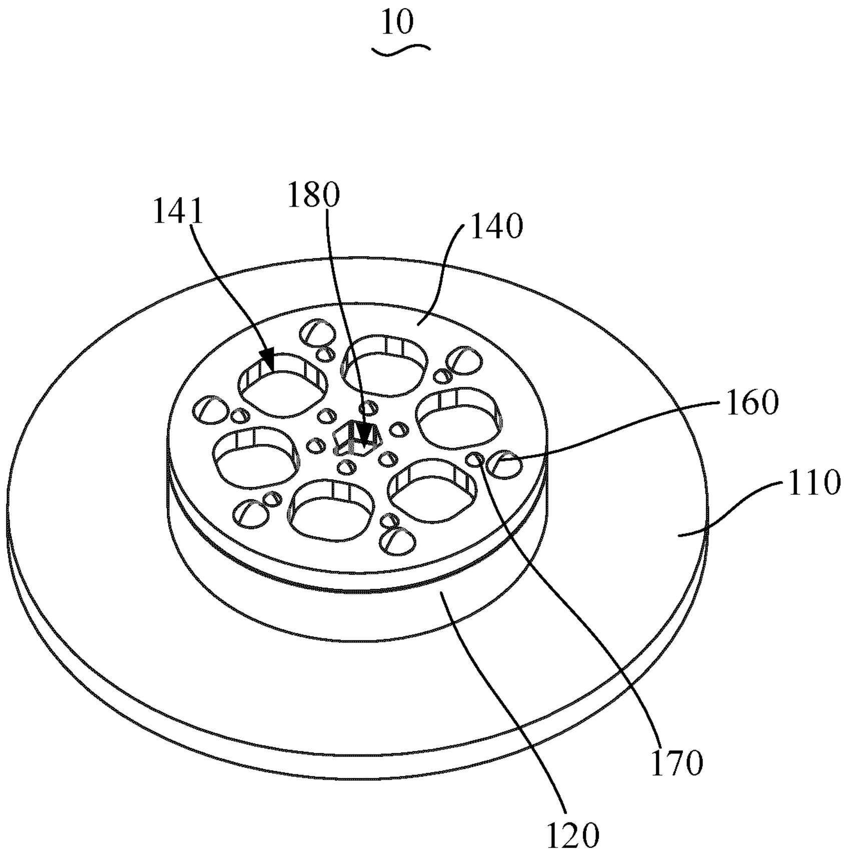

FIG. 1

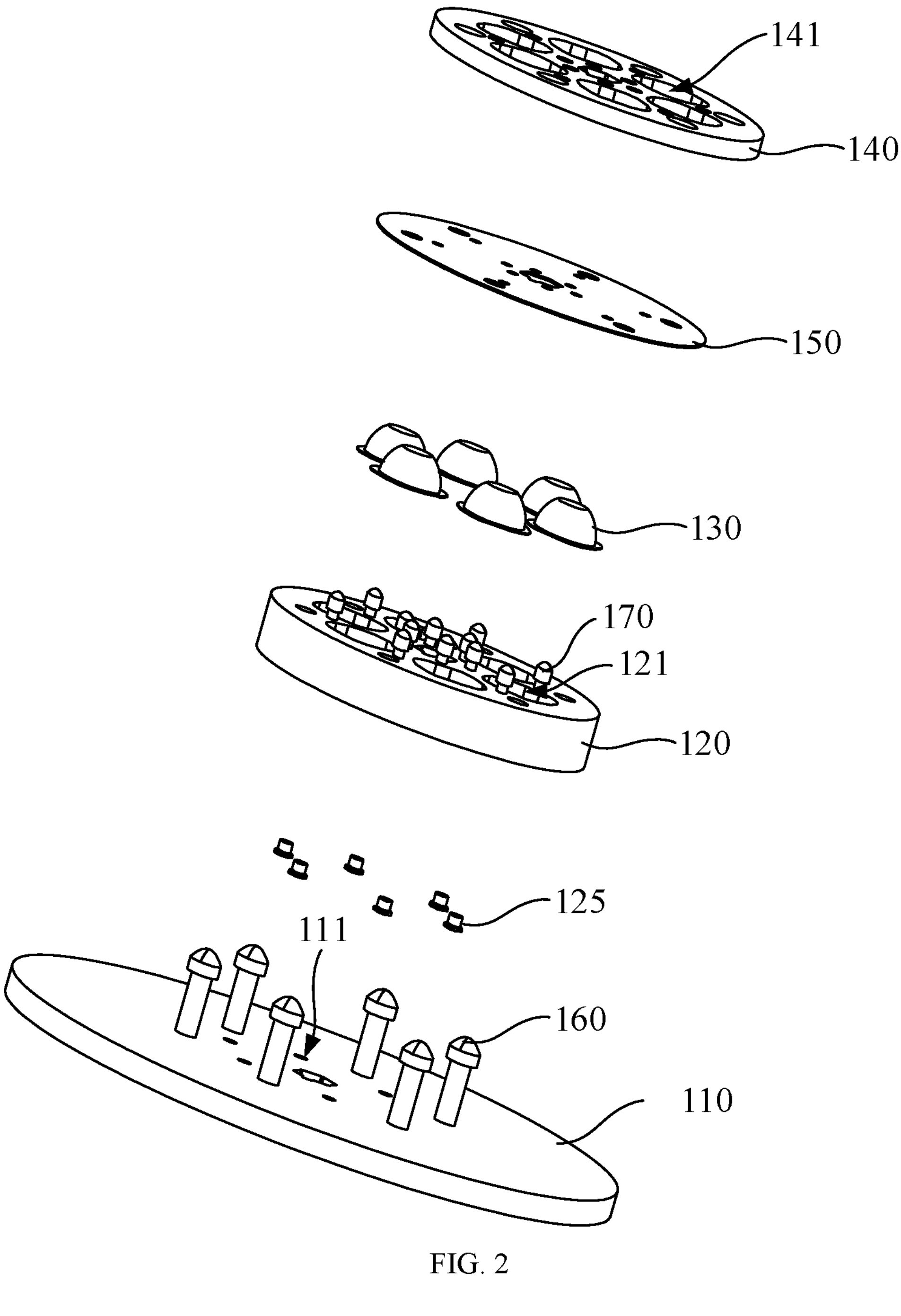

FIG. 2

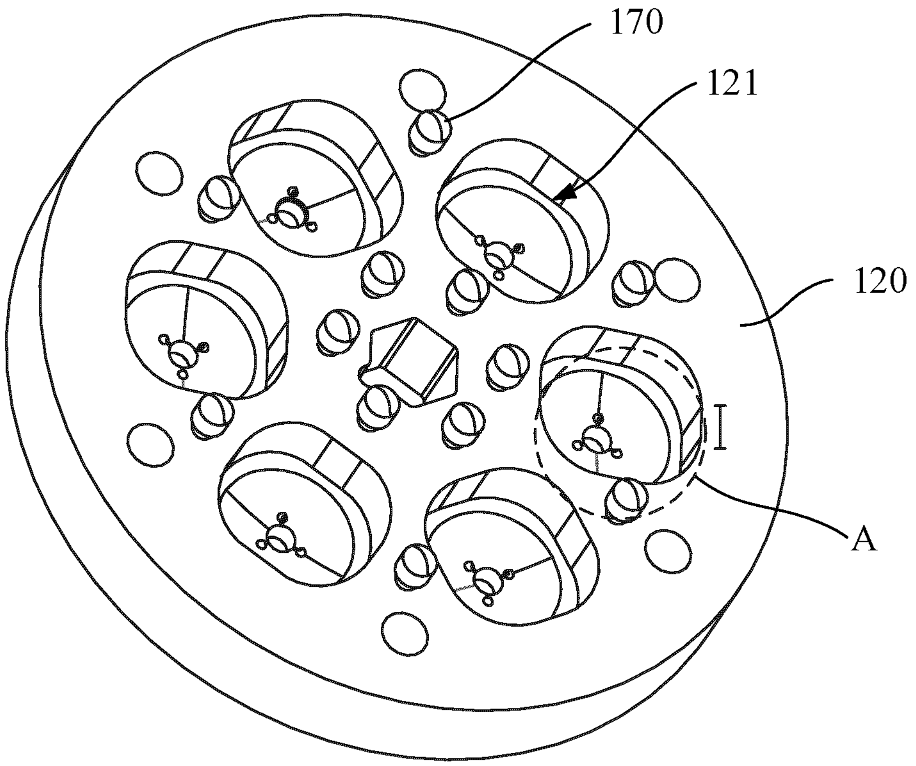

FIG. 3

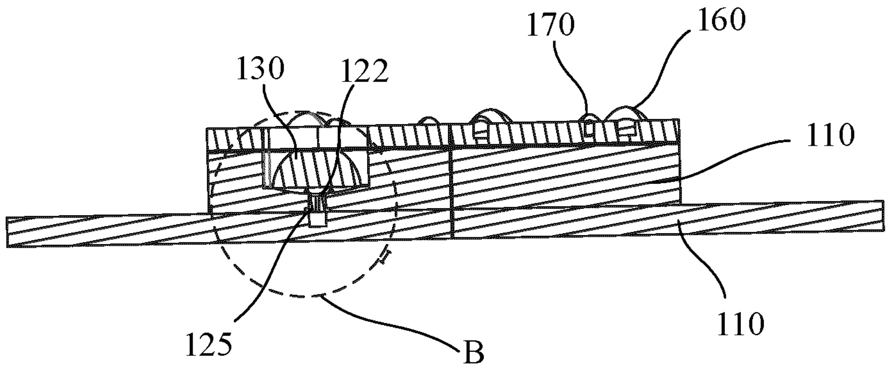

FIG. 4

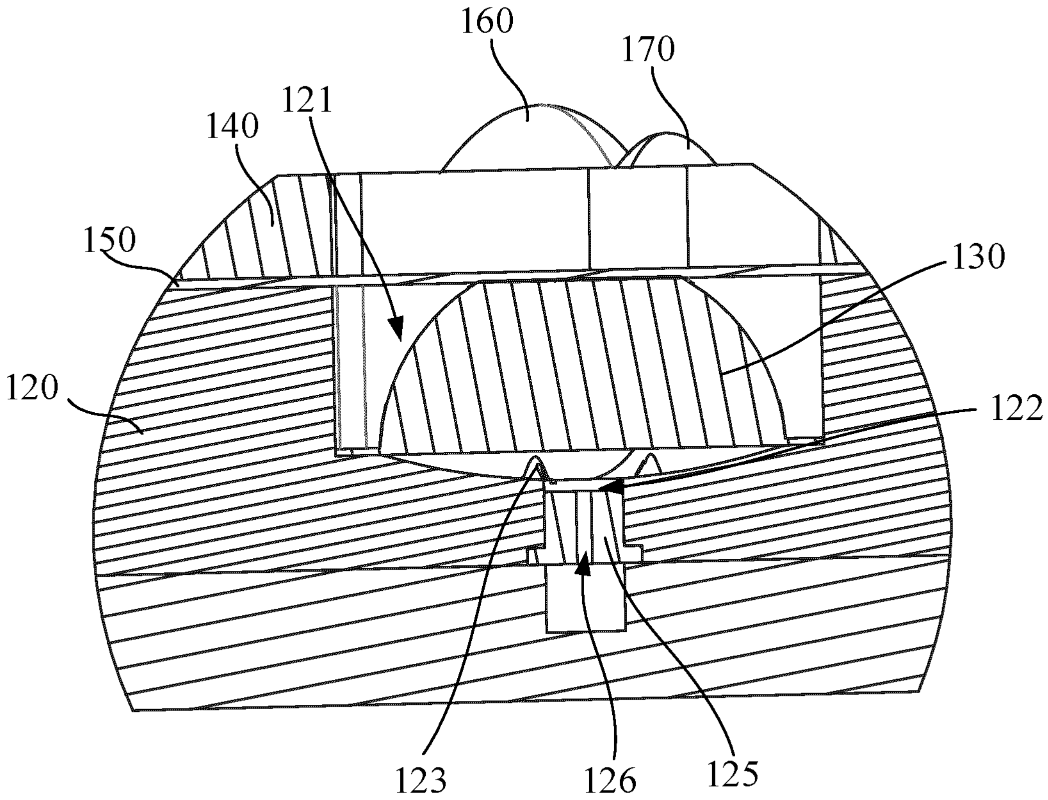

FIG. 5

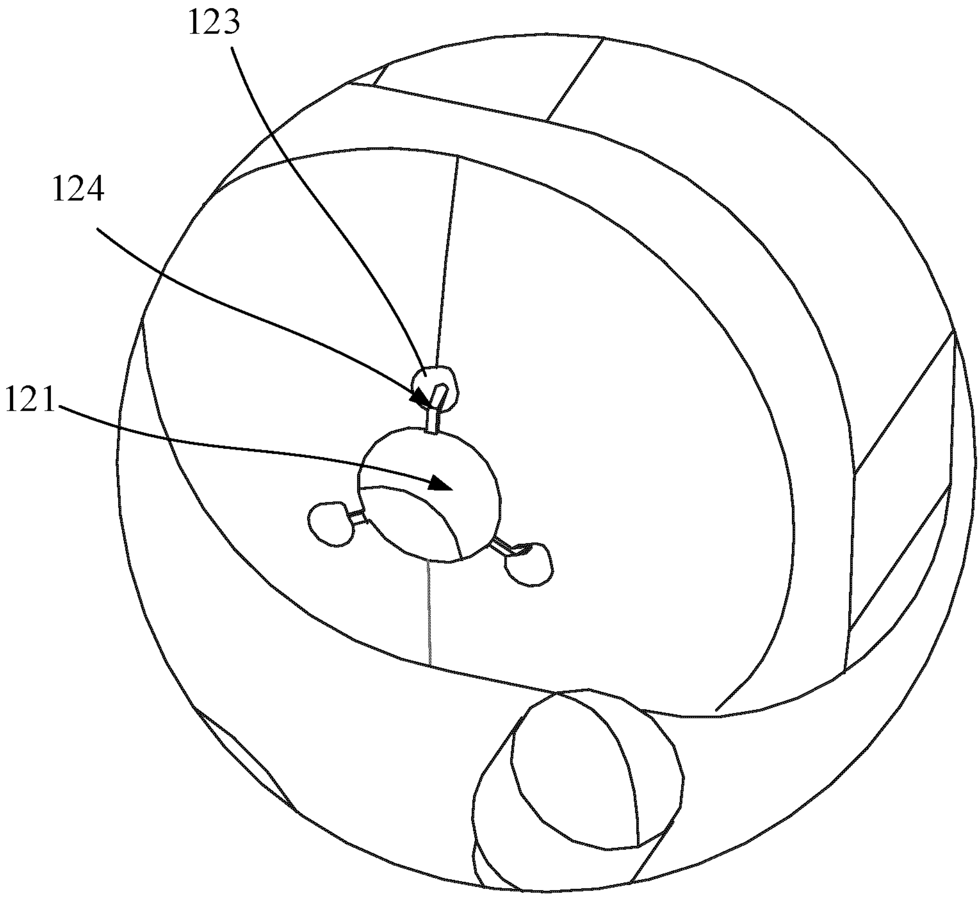

FIG. 6

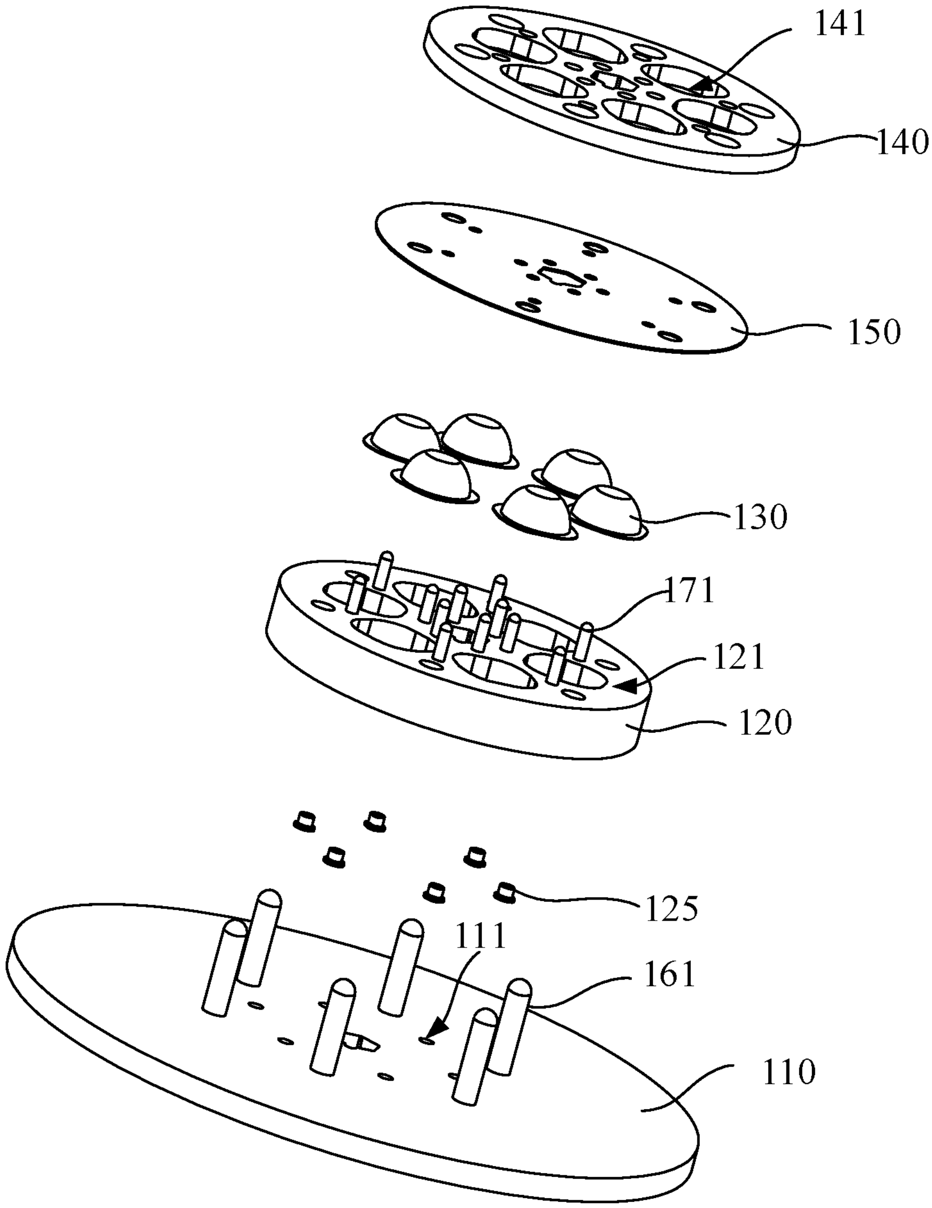

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/115034

A. CLASSIFICATION OF SUBJECT MATTER

B01L 3/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B01L

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

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

CNABS; CNTXT; CNKI; VEN; USTXT; WOTXT; EPTXT; Web of Science: 深圳市亚辉龙生物科技, 魏道舜, 程晓宇, 刘笔锋, 钱纯亘, 肖育劲, 陈鹏, 微流控芯片, 微阵列, 液囊, 膜, 囊, 包, 袋, 刺, 针, 锥, 破, 裂, 保护, 指示, 警, microfluidic, chip?, pierc+, punctur+, stab+, sting+, thorn, thrust+, protect+, indicat+, caution, observ+, membrane?, film?, vesicle?, wall?, break+, damag+, broken

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 113578405 A (SHENZHEN YHLO BIOTECH CO., LTD.) 02 November 2021 (2021-11-02) claims 1-10	1-10
X	CN 206965753 U (BEIJING BAICARE BIOTECHNOLOGY CO., LTD.) 06 February 2018 (2018-02-06) description, paragraphs [0009]-[0079], and figures 1 and 2	1-4, 7, 9, 10
X	CN 102149812 A (DECISION BIOMARKERS INC.) 10 August 2011 (2011-08-10) description, paragraphs [0135]-[0341], and figures 1-2	1-4, 7, 9, 10
A	WO 2006053588 A1 (AGILENT TECHNOLOGIES INC. et al.) 26 May 2006 (2006-05-26) entire document	1-10
A	CN 110252434 A (SHENZHEN HUAMAIXINGWEI MEDICAL TECHNOLOGY CO., LTD.) 20 September 2019 (2019-09-20) entire document	1-10

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

* Special categories of cited documents:
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 November 2022	**28 November 2022**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China**	
Facsimile No. **(86-10)62019451**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/115034

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 109847820 A (TIANJIN NUOMAI TECHNOLOGY CO., LTD.) 07 June 2019 (2019-06-07) entire document	1-10

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/115034

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				CA	2715985	A1	27 August 2009
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				US	2011207621	A1	25 August 2011
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				CN	110252434	B	09 August 2022
CN	109847820	A	07 June 2019	CN	210279191	U	10 April 2020

Form PCT/ISA/210 (patent family annex) (January 2015)