



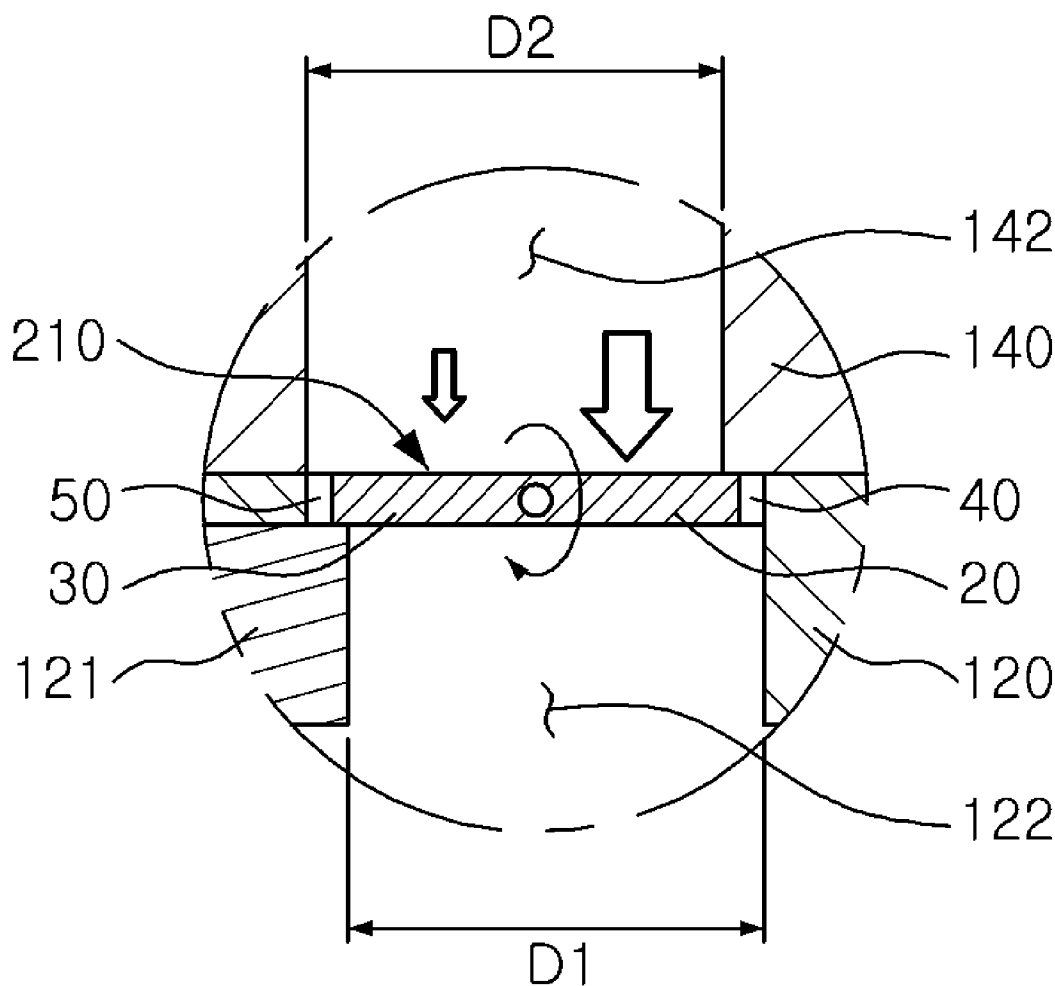
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**KIM et al.**(10) **Pub. No.: US 2014/0294629 A1**(43) **Pub. Date: Oct. 2, 2014**(54) **MICRO PUMP****Publication Classification**(71) Applicant: **SAMSUNG ELECTRO-MECHANICS  
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(2013.01); **F04B 13/00** (2013.01)  
USPC ..... **417/413.2**; 417/480(57) **ABSTRACT**

There is provided a micro pump including a bottom substrate, a channel forming substrate coupled to the bottom substrate and provided with an inlet into which a fluid is introduced and an outlet through which the fluid is discharged, and a valve integrally formed with the channel forming substrate.



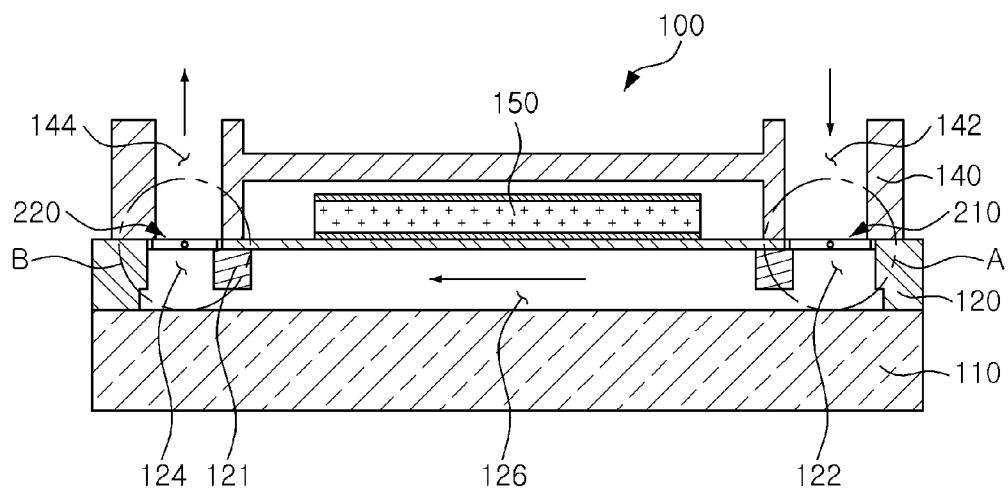


FIG. 1

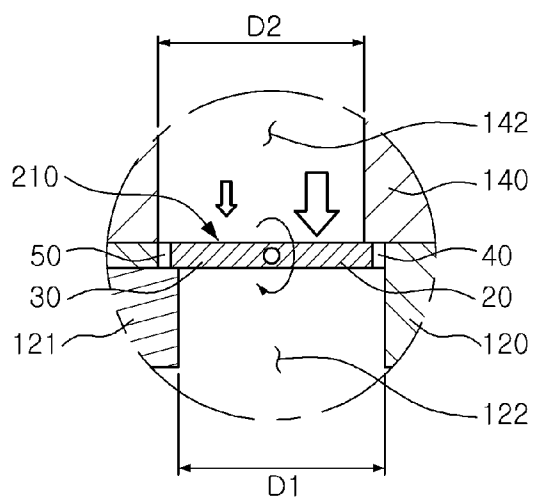


FIG. 2

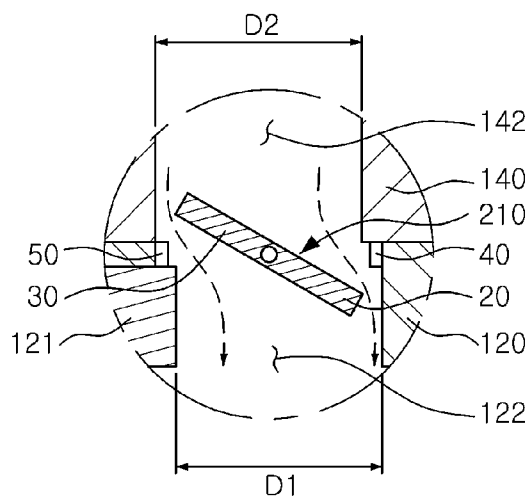


FIG. 3

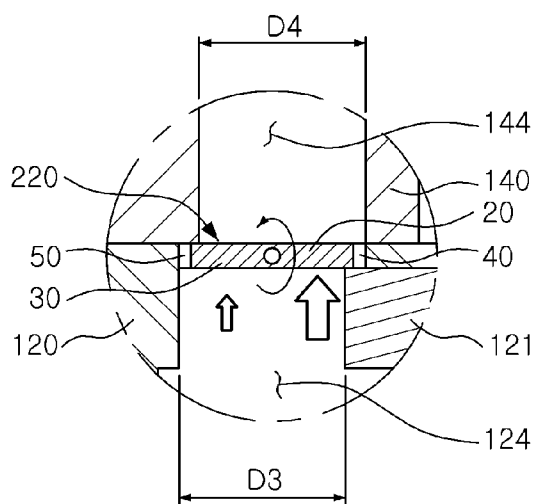


FIG. 4

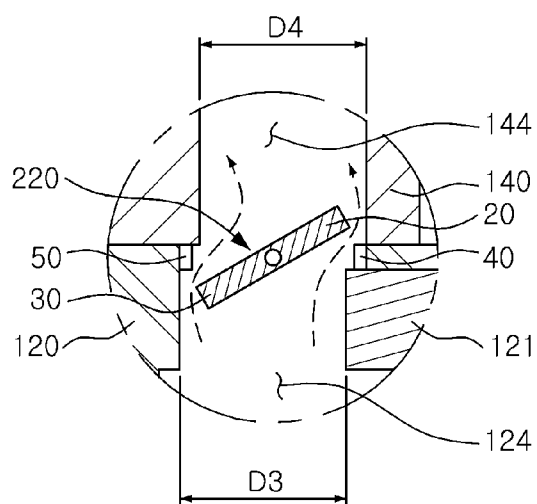


FIG. 5

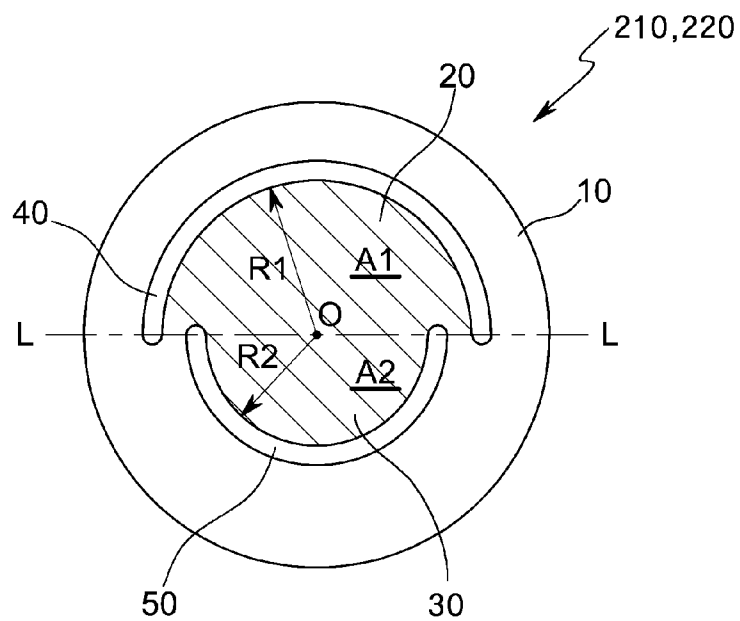


FIG. 6

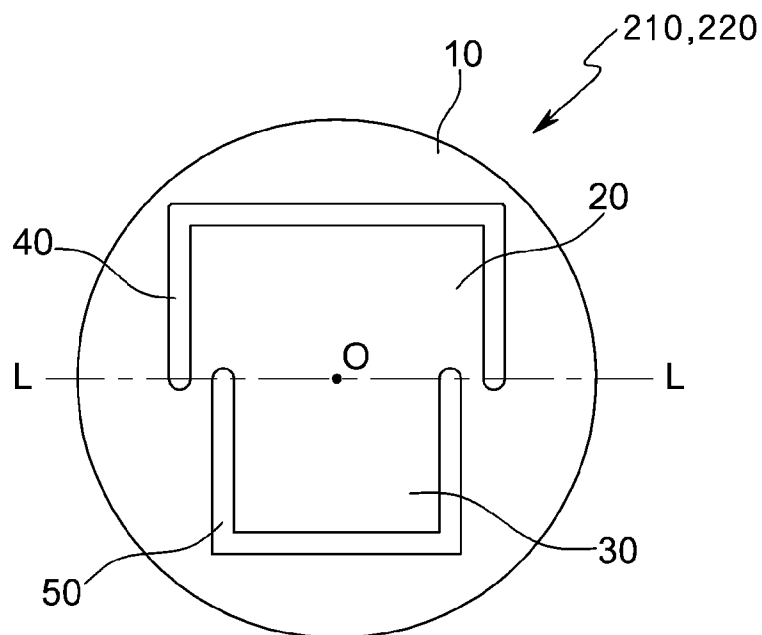


FIG. 7

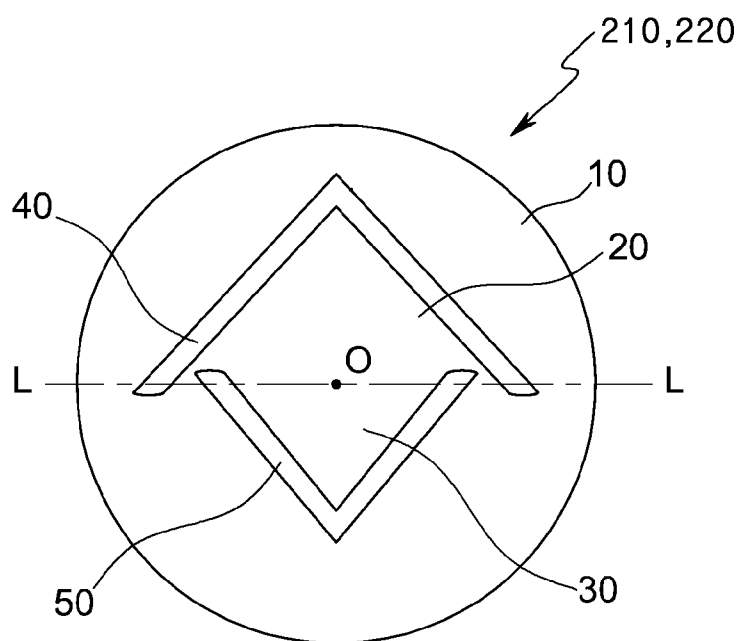


FIG. 8

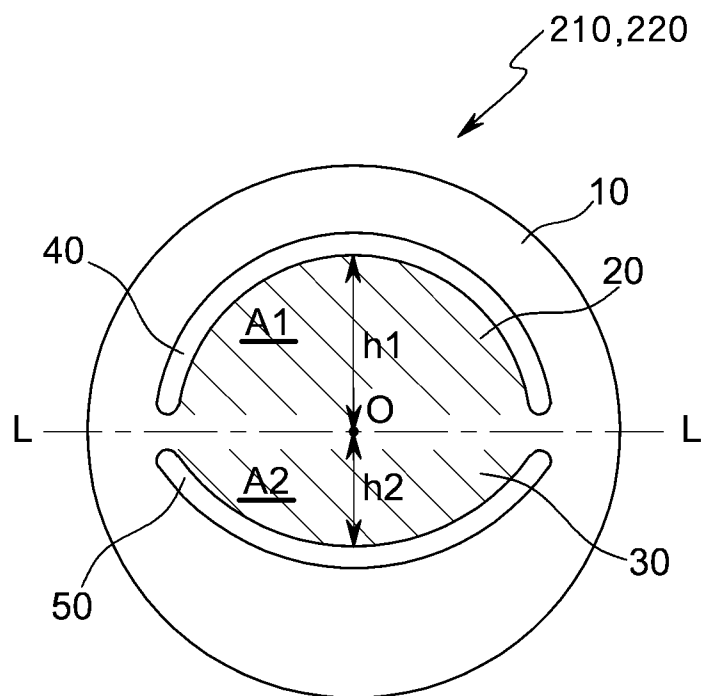


FIG. 9

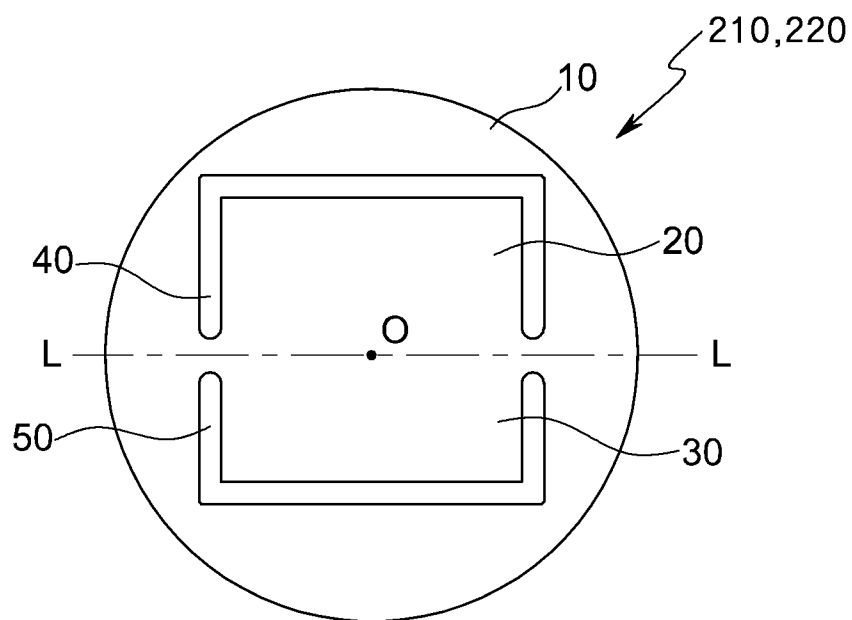


FIG. 10

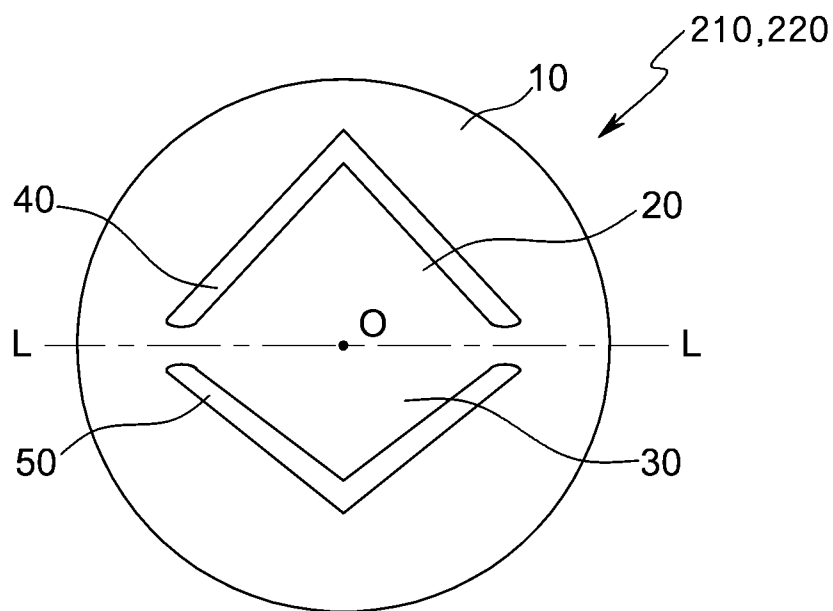


FIG. 11

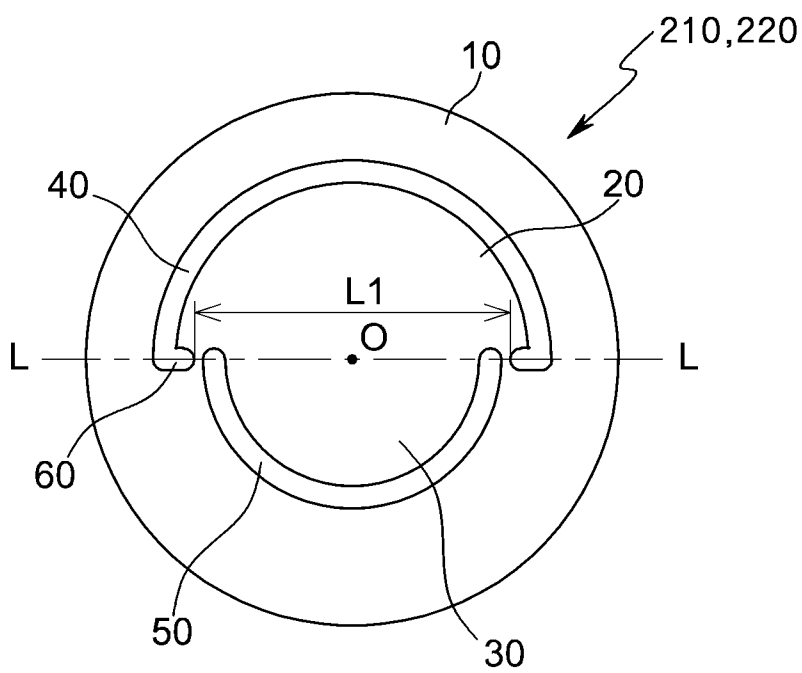


FIG. 12

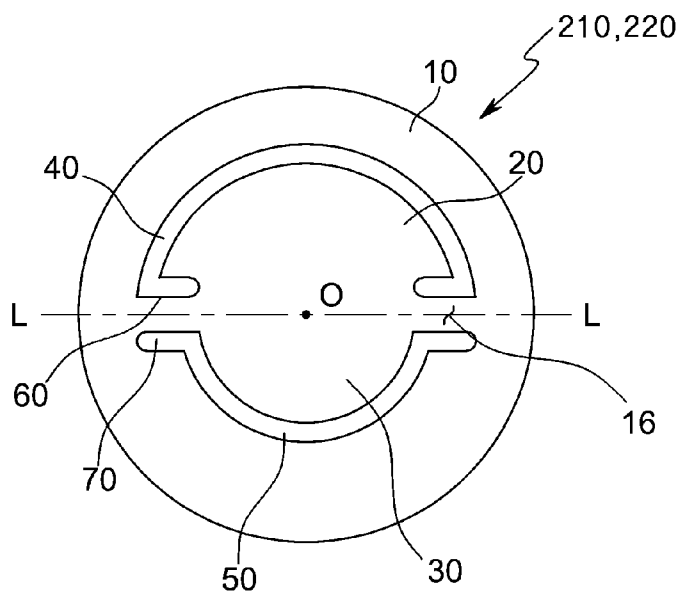


FIG. 13

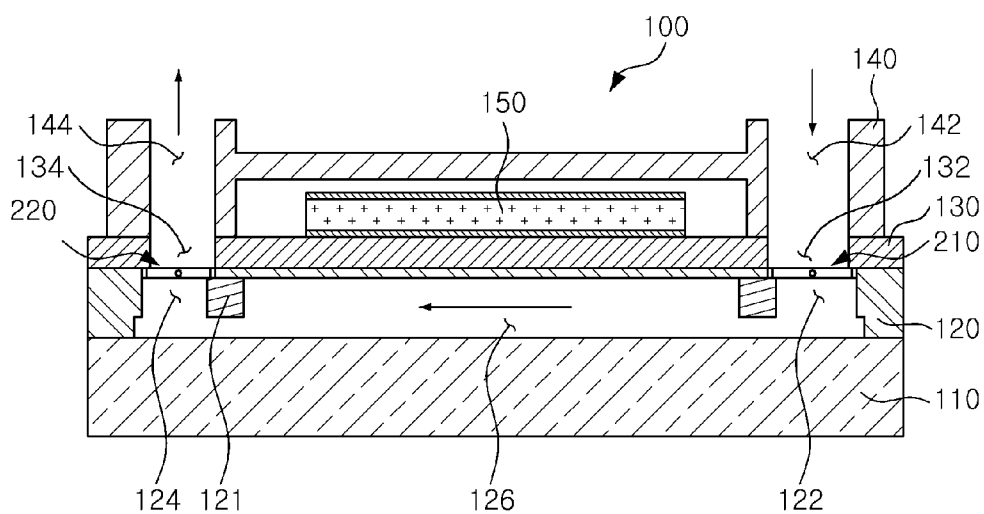


FIG. 14

## MICRO PUMP

### CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority of Korean Patent Application No. 10-2013-0034669 filed on Mar. 29, 2013, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

### BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a micro pump, and more particularly, to a micro pump repeatedly supplying an extremely small quantity of fluid and having a channel forming substrate and a valve integrally formed therein.

[0004] 2. Description of the Related Art

[0005] In order to develop new medicines and to perform experiments to determine the stability thereof, it is essential to observe a reaction between new medicines (that is, drugs) and cells. In general, a reaction experiment between the drug and the cell is performed using a culture dish or the like.

[0006] However, since reaction between drugs and the cells in experiments performed within the culture dish are very different from reactions between drugs and cells in experiments performed within living bodies, it is difficult to accurately observe or inspect reactions between drugs and cells through only experimental results using culture dishes. Therefore, there is a need to develop new apparatuses allowing for the observation of reactions between drugs and cells in an environment similar to that of the interior of a living body.

[0007] To this end, the present inventors developed a technology for circulating a culture medium. However, in order to smoothly culture the cell, there is a need to repeatedly supply an extremely small quantity of such a culture medium. To this end, a need exists for the development of a micro pump capable of repeatedly supplying an extremely small quantity of fluid.

[0008] As related art regarding the micro pump, there are provided Patent Documents 1 and 2. Patent Documents 1 and 2 relate to a technology for moving an extremely small quantity of fluid by a driving force of a piezoelectric element.

[0009] However, Patent Document 1 does not disclose a valve completely interrupting a flow of fluid, such that it may be difficult to deliver a fixed quantity of fluid. In contrast, Patent Document 2 relates to a technology for delivering a fixed quantity of fluid due to valves respectively disposed on respective upper substrates, but does not disclose a structure in which a channel forming substrate and the valve substrates are integrally formed.

### RELATED ART DOCUMENT

[0010] [Patent Document 1] KR 2008-070358 A

[0011] [Patent Document 2] JP 2000-249074 A

### SUMMARY OF THE INVENTION

[0012] An aspect of the present invention provides a micro pump repeatedly supplying an extremely small quantity of fluid and having a channel forming substrate and a valve integrally formed therein.

[0013] According to an aspect of the present invention, there is provided a micro pump, including: a bottom substrate; a channel forming substrate coupled to the bottom substrate and provided with an inlet into which a fluid is

introduced and an outlet through which the fluid is discharged; and a valve integrally formed with the channel forming substrate.

[0014] A first surface of the channel forming substrate may be provided with the inlet and the outlet and a second surface of the channel forming substrate may be provided with a pressure chamber that connects the inlet to the outlet.

[0015] The micro pump may further include: an actuator formed on the first surface of the channel forming substrate and applying pressure to the pressure chamber.

[0016] The bottom substrate and the channel forming substrate may be formed of single crystal silicon or silicon on insulator (SOI).

[0017] The upper substrate may be formed of a plastic or synthetic resin material.

[0018] The micro pump may further include: an upper substrate coupled to the channel forming substrate.

[0019] The upper substrate may be provided with a first hole connected to the inlet and a second hole connected to the outlet.

[0020] The valve may include: a thin film member; a first opening and closing member formed by a first cut off line cutting off a portion of the thin film member; and a second opening and closing member formed by a second cut off line cutting off another portion of the thin film member.

[0021] A length of the first cut off line may be longer than that of the second cut off line.

[0022] The first cut off line may have a curved shape having a first radius and the second cut off line may have a curved shape having a second radius.

[0023] The first radius and the second radius may have different sizes.

[0024] According to an aspect of the present invention, there is provided a micro pump, including: a bottom substrate; a channel forming substrate coupled to the bottom substrate and provided with an inlet into which a fluid is introduced and an outlet through which the fluid is discharged; a vibration substrate coupled to the channel forming substrate; and a valve integrally formed with the channel forming substrate.

[0025] The channel forming substrate may be provided with the inlet, the outlet, and a pressure chamber that connects the inlet to the outlet.

[0026] The micro pump may further include: an actuator formed on the first surface of the vibration substrate and applying pressure to the pressure chamber.

[0027] The bottom substrate, the channel forming substrate, and the vibration substrate may be formed of single crystal silicon or silicon on insulator (SOI).

[0028] The micro pump may further include: an upper substrate coupled to the channel forming substrate.

[0029] The upper substrate may be provided with a first hole connected to the inlet and a second hole connected to the outlet.

[0030] The valve may include a thin film member; a first opening and closing member formed by a first cut off line cutting off a portion of the thin film member; and a second opening and closing member formed by a second cut off line cutting off another portion of the thin film member.

[0031] A length of the first cut off line may be longer than that of the second cut off line.

[0032] The first cut off line may have a curved shape having a first radius and the second cut off line may have a curved shape having a second radius.

[0033] The first radius and the second radius may have different sizes.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0034] The above and other aspects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0035] FIG. 1 is a cross-sectional view of a micro pump according to an embodiment of the present invention;

[0036] FIG. 2 is an enlarged view of part A illustrated in FIG. 1;

[0037] FIG. 3 is an enlarged view illustrating a method of operating a valve illustrated in FIG. 2;

[0038] FIG. 4 is an enlarged view of part B illustrated in FIG. 1;

[0039] FIG. 5 is an enlarged view illustrating a method of operating a valve illustrated in FIG. 4;

[0040] FIGS. 6 to 13 are diagrams illustrating another form of a valve; and

[0041] FIG. 14 is a cross-sectional view of a micro pump according to another embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

[0042] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein.

[0043] Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

[0044] FIG. 1 is a cross-sectional view of a micro pump according to an embodiment of the present invention and FIGS. 2 to 5 are enlarged views of parts A and B illustrated in FIG. 1.

[0045] A micro pump 100 according to an embodiment of the present invention will be described with reference to FIGS. 1 to 5.

[0046] The micro pump 100 according to the embodiment of the present invention may include a bottom substrate 110, a channel forming substrate 120, and an upper substrate 140. In addition, the micro pump 100 may further include an actuator 150, as needed. Herein, the bottom substrate 110, the channel forming substrate 120, and the upper substrate 140 may be sequentially stacked.

[0047] The bottom substrate 110 may form a base part of the micro pump 100. The bottom substrate 110 may be formed of single crystal silicon or silicon on insulator (SOI). In this case, the bottom substrate 110 may be a stacked structure in which a silicon substrate and a plurality of insulating members are stacked.

[0048] The channel forming substrate 120 may be a substrate on which a channel through which a fluid (for example, a culture medium or a drug) is delivered is formed. To this end, a first surface (an upper surface as viewed in FIG. 1) of the channel forming substrate 120 may be provided with an inlet 122 and an outlet 124 and a second surface (a lower surface as viewed in FIG. 1) may be provided with a pressure chamber 126. Herein, the pressure chamber 126 may connect the inlet 122 to the outlet 124 and may have a volume that may receive a predetermined quantity of fluid.

[0049] Likewise the bottom substrate 110, the channel forming substrate 120 may be formed of single crystal silicon or silicon on insulator (SOI). The channel forming substrate 120 formed as described above may be subjected to a burning process so as to be integrally formed with the bottom substrate 110.

[0050] Valves 210 and 220 may be integrally formed with the channel forming substrate 120.

[0051] When a thickness of the valves 210 and 220 is the same as that of the channel forming substrate 120, the number of processes is reduced, such that time and cost consumed in performing the process may be reduced.

[0052] In addition, when the thickness of the channel forming substrate 120 is the same as that of the valves 210 and 220, an amount of force required to open and close the valves 210 and 220 may vary due to the thickness of the channel forming substrate 120.

[0053] Therefore, the force required to open and close the valves 210 and 220 may be controlled by controlling the thickness of the channel forming substrate 120.

[0054] The valves 210 and 220 may be formed in the inlet 122 and the outlet 124 of the channel forming substrate 120, respectively, such that a fluid may move in a single direction by forming.

[0055] The upper substrate 140 may be formed on one surface of the channel forming substrate 120 and may control a flow of fluid flowing in the channel forming substrate 120.

[0056] The upper substrate 140 may be provided with a first hole 142 and a second hole 144. Herein, the first hole 142 may be connected to the inlet 122 of the channel forming substrate 120 and the second hole 144 may be connected to the outlet 124 of the channel forming substrate 120.

[0057] The valves 210 and 220 may be formed in the inlet 122 and the outlet 124, respectively. In other words, the first valve 210 may be mounted in the inlet 122 and the second valve 220 may be mounted at the outlet 124. Meanwhile, the embodiment of the present invention describes that the valves are mounted at both of the inlet 122 and the outlet 124, but the valve may be mounted only in one hole, as needed.

[0058] The upper substrate 140 may be formed of plastic or a synthetic resin material. In this case, the upper substrate 140 is easily machined, and thus the manufacturing cost of the upper substrate 140 may be saved. However, the upper substrate 140 may also be formed of the silicon substrate, as needed.

[0059] An actuator 150 may be formed on the channel forming substrate 120. In other words, the actuator 150 may be formed on one surface (an upper surface as viewed in FIG. 1) of the channel forming substrate 120. The actuator 150 may be configured of a lower electrode, a piezoelectric element, an upper electrode. In other words, the lower electrode may be formed on an upper surface of the channel forming substrate 120, the piezoelectric element may be formed on an upper surface of the lower electrode, and the upper electrode may be formed on an upper surface of the piezoelectric element. The actuator 150 configured as described above may generate driving force in response to the deformation of the piezoelectric element by current signals provided through the upper electrode and the lower electrode. Herein, the driving force of the actuator 150 may be transferred to the pressure chamber 126 of the channel forming substrate 120 to move a fluid.

[0060] Meanwhile, the micro pump 100 configured as described above may only move a fluid in a single direction

through the valves **210** and **220**. Portions associated therewith will be described with reference to FIGS. **2** to **5**.

[0061] An inlet side (a portion represented by A in FIG. **1**) of the micro pump **100** may be configured as illustrated in FIG. **2**.

[0062] In other words, the inlet **122** of the channel forming substrate **120** may have a size of a first diameter D1 and the first hole **142** of the upper substrate **140** may have a size of a second diameter D2, thereby leading to the circulation of the fluid in a single direction.

[0063] Herein, a first opening and closing member **20** and a second opening and closing member **30** of the valve **210** have different areas, such that a force (F1) applied to the first opening and closing member **20** and a force (F2) applied to the second opening and closing member **30** are different at all times even in the case that a uniform amount of pressure is applied to the valve **210**. Therefore, the first opening and closing member **20** and the second opening and closing member **30** may have inertia to be rotated in a single direction (a clockwise direction in FIG. **2**) at all times.

[0064] However, when a difference (F1-F2) between the force (F1) applied to the first opening and closing member **20** and the force (F2) applied to the second opening and closing member **30** does not exceed a predetermined reference force (for example, an elastic force of the valve **210**), the members **20** and **30** may be kept in a closed state (see FIG. **2**).

[0065] A backflow prevention step **121** maybe formed on an upper portion of the first opening and closing member **20** of the valve **210** to prevent a fluid from backflowing.

[0066] In addition, the backflow prevention step **121** may be formed on a lower portion of the second opening and closing member **30** of the valve **210** to prevent fluid from backflowing.

[0067] The backflow prevention step **121** may be formed by etching the channel forming substrate **120** stepwise and may also be formed by attaching a separate attachment thereto.

[0068] When the backflow prevention step **121** is provided, the possibility of the backflow of fluid may be reduced.

[0069] In this state, when the difference (F1-F2) between the force (F1) applied to the first opening and closing member **20** and the force (F2) applied to the second opening and closing member **30** exceeds the predetermined reference force due to the increase in a flux of fluid, the opening and closing members **20** and **30** may be rotated and thus opened, as illustrated in FIG. **3**.

[0070] Meanwhile, the valve **210** according to the embodiment of the present invention may prevent the opening and closing members **20** and **30** from shaking severely and may be rapidly opened and closed in response to a change in the flux of fluid, even in the case that the flow of fluid is irregular, since the rotation of the opening and closing members **20** and **30** is performed in the vicinity of a central point of a thin film member **10**.

[0071] Further, the valve **210** according to the embodiment of the present invention may control the opening and closing conditions of the opening and closing members **20** and **30** based on the area of the opening and closing members **20** and **30**, and thus may also control an extremely small quantity of flux.

[0072] Further, based on torsion, it is determined whether the valve **210** is opened or closed, and an amount of force required to open and close the valve may be controlled by controlling the thickness of the channel forming substrate **120**.

[0073] Further, in the valve **210**, a difference between radii of the first and second cut off lines (**40** and **50**) may be controlled to thus control force required to open and close the valve.

[0074] In addition, a resonance frequency of the valve **210** is the same as a driving frequency of the actuator **150** by controlling a difference between radii of the first and second cut off lines **40** and **50** of the valve **210**, such that the valve **210** may be controlled to be easily opened and closed at the driving frequency of the actuator **150**.

[0075] An outlet side (a portion represented by B in FIG. **1**) of the micro pump **100** may be configured as illustrated in FIG. **4**.

[0076] In other words, the outlet **124** of the channel forming substrate **120** may have a size of a third diameter D3, and the second hole **144** of the upper substrate **140** may have a size of a fourth diameter D4, thereby leading to the circulation of the fluid in a single direction.

[0077] Herein, the first opening and closing member **20** and the second opening and closing member **30** of the valve **220** have different areas, such that the force (F1) applied to the first opening and closing member **20** and the force (F2) applied to the second opening and closing member **30** are different at all times even in the case that uniform pressure is applied to the valve **220**. Therefore, the first opening and closing member **20** and the second opening and closing member **30** may have inertia to be rotated in a single direction (a clockwise direction in FIG. **3**) at all times.

[0078] However, when a difference (F1-F2) between the force (F1) applied to the first opening and closing member **20** and the force (F2) applied to the second opening and closing member **30** does not exceed a predetermined reference force (for example, an elastic force of the valve **220**), the members **20** and **30** may be kept in a closed state (see FIG. **3**).

[0079] The backflow prevention step **121** may be formed on the lower portion of the first opening and closing member **20** of the valve **220** to prevent a fluid from backflowing.

[0080] In addition, the backflow prevention step **121** may be formed on the upper portion of the second opening and closing member **30** of the valve **220** to prevent a fluid from backflowing.

[0081] The backflow prevention step **121** may be formed by etching the channel forming substrate **120** stepwise and may also be formed by attaching a separate attachment thereto.

[0082] When the backflow prevention step **121** exists, the possibility of the backflow of fluid may be reduced.

[0083] In this state, when the difference (F1-F2) between the force (F1) applied to the first opening and closing member **20** and the force (F2) applied to the second opening and closing member **30** exceeds the predetermined reference force due to the increase in a flux of fluid, the opening and closing members **20** and **30** may be rotated and thus opened, as illustrated in FIG. **5**.

[0084] Meanwhile, the valve **220** according to the embodiment of the present invention may prevent the opening and closing members **20** and **30** from shaking severely and may be rapidly opened and closed in response to a change in the flux of fluid, even in the case that the flow of fluid is irregular, since the rotation of the opening and closing members **20** and **30** is performed in the vicinity of a central point of the thin film member **10**.

[0085] Further, in the valve **220** according to the embodiment of the present invention, the opening and closing conditions of the opening and closing members **20** and **30** may be

controlled based on the area of the opening and closing members 20 and 30, and thus, an extremely small quantity of flux may be adjusted.

[0086] Further, based on torsion, it is determined whether the valve 220 is opened or closed and force required to open and close the valve may be controlled by controlling the thickness of the channel forming substrate 120.

[0087] Further, in the valve 220, a difference between radii of the first and second cut off lines 40 and 50 may be controlled to thus control force required to open and close the valve.

[0088] That is, a resonance frequency of the valve 220 is the same as a driving frequency of the actuator 150 by controlling a difference between radii of the first and second cut off lines 40 and 50 of the valve 220, such that the valve 220 may be controlled to be easily opened and closed at the driving frequency of the actuator 150.

[0089] Further, since in the micro pump 100, the valves 210 and 220 may be integrally formed with the channel forming substrate 120, the manufacturing process of the micro pump 100 may be simplified and the manufacturing costs thereof may be saved.

[0090] Next, another form of the valve will be described with reference to FIGS. 6 to 13. First, the valves 210 and 220 according to a first embodiment of the present invention will be described with reference to FIGS. 6 to 8.

[0091] The valves 210 and 220 according to the first embodiment of the present invention may include the thin film member 10, the first opening and closing member 20, and the second opening and closing member 30. Herein, the thin film member 10, the first opening and closing member 20, and the second opening and closing member 30 may be integrally formed. In other words, the first opening and closing member 20 and the second opening and closing member 30 may be formed by machining the thin film member 10.

[0092] The thin film member 10 may be a membrane having a circular cross-section. However, a cross-sectional shape of the thin film member 10 is not limited to a circle. For example, the thin film member 10 may have a polygonal cross-section, including a quadrangular shape.

[0093] The thin film member 10 may be formed of an elastic material. In other words, the thin film member 10 may be formed of a material that may be warped or deformed when a predetermined amount of force is applied thereto. For example, the thin film member 10 may be formed of a material, such as plastic, rubber, synthetic resin, metal, or the like. However, a material of the thin film member 10 is not limited only to the listed materials, and therefore the thin film member 10 may be formed of any material having a predetermined degree of elastic force.

[0094] The first opening and closing member 20 may be formed in one portion of the thin film member 10. In other words, the first opening and closing member 20 may be formed on the upper portion of the thin film member 10 by the first cut off line 40. Herein, the first cut off line 40 may be a curved line having a first radius R1. In this case, the first opening and closing member 20 may have an approximately semi-circular shape. However, the shape of the first opening and closing member 20 and the first cut off line 40 is not limited to a shape illustrated in FIG. 6. For example, the first opening and closing member 20 may have a rectangular or squared shape and the first cut off line 40 may be configured of a plurality of straight lines, rather than as curved lines, as illustrated in FIGS. 7 and 8.

[0095] The first opening and closing member 20 may be opened and closed based on a horizontal line segment L-L. For example, the first opening and closing member 20 may be rotated based on the horizontal line segment L-L. Herein, the rotation direction of the first opening and closing member 20 may be changed according to the mounting position of the valves 210 and 220.

[0096] The second opening and closing member 30 may be formed in one portion of the thin film member 10. In other words, the first opening and closing member 30 may be formed on the lower portion of the thin film member 10 by the second cut off line 50. Herein, the second cut off line 50 may be a curved line having a second radius R2. In this case, the second opening and closing member 30 may have an approximately semi-circular shape. However, the shape of the second opening and closing member 30 and the second cut off line 50 is not limited to a shape illustrated in FIG. 6. For example, the second opening and closing member 30 may have a rectangular or squared shape and the second cut off line 50 may be configured of a plurality of straight lines, rather than a curved line, as illustrated in FIGS. 7 and 8.

[0097] The second opening and closing member 30 may be opened and closed based on the horizontal line segment L-L, like the first opening and closing member 20. For example, the second opening and closing member 30 may be rotated based on the horizontal line segment L-L. Herein, the rotation direction of the second opening and closing member 30 may be opposite to the rotation direction of the first opening and closing member 20. For example, when the first opening and closing member 20 is opened forwardly, the second opening and closing member 30 may be opened backwardly and when the first opening and closing member 20 is opened backwardly, the second opening and closing member 30 may be opened forwardly.

[0098] The first opening and closing member 20 and the second opening and closing member 30 may respectively have a predetermined area. In other words, the first opening and closing member 20 may have a first area A1 and the second opening and closing member 30 may have a second area A2. Herein, the first area A1 of the first opening and closing member 20 may be larger than the second area A2 of the second opening and closing member 30. To this end, a length of the first cut off line 40 may be longer than that of the second cut off line 50. Alternatively, the first radius R1 of the first cut off line 40 may be larger than the second radius R2 of the second cut off line 50.

[0099] As such, when the area of the first opening and closing member 20 and the area of the second opening and closing member 30 are formed differently, the magnitude of the force applied to the first opening and closing member 20 and the second opening and closing member 30 may be different. This may concentrate force on the first opening and closing member 20, such that the rotation (that is, opening) of the first opening and closing member 20 may be induced. Herein, the first opening and closing member 20 and the second opening and closing member 30 substantially move integrally, such that the rotation of the first opening and closing member 20 may also induce the rotation of the second opening and closing member 30. Therefore, according to the embodiment of the present invention, the flow of fluid may be controlled by opening or closing the first opening and closing member 20 and the second opening and closing member 30 simultaneously.

[0100] Meanwhile, a difference in the areas of the first opening and closing member 20 and the second opening and closing member 30 may be changed according to the magnitude of the elastic force of the thin film member 10. For example, when the elastic force of the thin film member 10 is relatively large, the difference in the areas of the first opening and closing member 20 and the second opening and closing member 30 may be large, and when the elastic force of the thin film member 10 is relatively small, the difference in the areas of the first opening and closing member 20 and the second opening and closing member 30 may be relatively small. The reason is that only when the force depending on the difference in the areas of the first opening and closing member 20 and the second opening and closing member 30 is large than the elastic force of the thin film member 10, the opening and closing members 20 and 30 may be rotated.

[0101] For reference, in the embodiment of the present invention, both ends of the first cut off line 40 and both ends of the second cut off line 50 may be located on the horizontal line segment L-L passing through a central point O. In this case, rotating reference points of the first opening and closing member 20 and the second opening and closing member 30 are located on the same line, such that the simultaneous rotation of the first opening and closing member 20 and the second opening and closing member 30 may be smoothly performed.

[0102] In the valves 210 and 220 configured as described above, the opening conditions of the opening and closing members 20 and 30 may be set by forming the first opening and closing member 20 and the second opening and closing member 30 to have different sizes. Therefore, even in the case of a pipe through which an extremely small quantity of fluid moves, the flow of fluid may be effectively controlled by controlling the difference in the areas of the first opening and closing member 20 and the second opening and closing member 30.

[0103] Next, the valves 210 and 220 according to a second embodiment of the present invention will be described with reference to FIGS. 9 to 11.

[0104] The valves 210 and 220 according to the second embodiment of the present invention may be differentiated from the first embodiment of the present invention in that heights from the central point O of the thin film member 10 to apexes of the cut off lines 40 and 50 are different. That is, a height h1 from the central point O to the apex of the first cut off line 40 may be different from a height h2 from the central point O to the apex of the second cut off line 50.

[0105] The structure may naturally induce the difference in the areas of the first opening and closing member 20 and the second opening and closing member 30. In addition, in the structure, a portion of separating both ends of the first cut off line 40 and the second cut off line 50 serves as a rotation shaft, such that the first opening and closing member 20 and the second opening and closing member 30 may be smoothly rotated.

[0106] Meanwhile, the shape of the first opening and closing member 20 and the second opening and closing member 30 may be changed as illustrated in FIGS. 10 and 11. To this end, the first cut off line 40 and the second cut off line 50 may be configured of a plurality of straight lines.

[0107] Next, a valve according to third and fourth embodiments of the present invention will be described with reference to FIGS. 12 and 13.

[0108] The third and fourth embodiments of the present invention may be differentiated from the above-mentioned embodiments in that the valves 210 and 220 include a third cut off line 60 and a fourth cut off line 70.

[0109] The valves 210 and 220 according to the third embodiment of the present invention may further include the third cut off line 60. The third cut off line 60 may extend inwardly (in a direction toward the central point O) from both ends of the first cut off line 40. The third cut off line 60 is not connected to the second cut off line 50, but may be located on the same line as both ends of the second cut off line 50.

[0110] In the valves 210 and 220 formed as described above, a connection length L1 between the thin film member 10 and the first opening and closing member 20 is relatively short by the third cut off line 60, such that the motion of the first opening and closing member 20 may be smoothly performed.

[0111] The valves 210 and 220 according to the fourth embodiment of the present invention may further include the third cut off line 60 and the fourth cut off line 70. The third cut off line 60 may extend inwardly from both ends of the first cut off line 40 and the fourth cut off line 70 may extend outwardly from both ends of the second cut off line 50. Herein, both ends of the first cut off line 40 and both ends of the second cut off line 50 are formed at a predetermined distance, and thus the third cut off line 60 and the fourth cut off line 70 may not be connected to each other.

[0112] In the valves 210 and 220 formed as described above, a shaft 16 that is a rotation reference of the first opening and closing member 20 and the second opening and closing member 30 is formed by the third cut off line 60 and the fourth cut off line 70, such that the first opening and closing member 20 and the second opening and closing member 30 may be smoothly rotated.

[0113] Next, a micro pump 100 according to another embodiment of the present invention will be described with reference to FIG. 14. For reference, in the present embodiment, the same reference numerals will be used to describe the same components as those of the above-mentioned embodiment and a detailed description of these components will be omitted.

[0114] The micro pump 100 according to the present embodiment may be differentiated from the above-mentioned embodiment in terms of the channel forming substrate 120 and a vibration substrate 130.

[0115] Similarly to the above-mentioned embodiment, the channel forming substrate 120 may include the inlet 122, the outlet 124, and the pressure chamber 126. However, in the present embodiment, the pressure chamber 126 may have a shape completely opened in a vertical direction, differently from the above-mentioned embodiment. The pressure chamber 126 having the shape may be easily formed in an etching process (in particular, a wet etching process), and the size and volume of the pressure chamber 126 may be easily changed by controlling the thickness of the channel forming substrate 120.

[0116] The vibration substrate 130 may be coupled to the channel forming substrate 120. The vibration substrate 130 may be formed of single crystal silicon or silicon on insulator (SOI). The vibration substrate 130 may be provided with through holes 132 and 134. Herein, the first through hole 132 may connect the inlet 122 with a first hole 142, and the second through hole 134 may connect the outlet 124 with a second hole 144.

[0117] In the micro pump 100 configured as described above, the channel forming substrate 120 may be easily manufactured through the etching process. In addition, the vibration substrate 130 is separately manufactured, and therefore the slimness of the vibration substrate 130 is easily implemented, such that power consumption required to drive the actuator 150 may be reduced.

[0118] As set forth above, according to the embodiment of the present invention, the fluid including the micro material in a micro unit may be effectively delivered.

[0119] Further, according to the embodiment of the present invention, the channel forming substrate and the valve may be integrally formed in the micro pump, thereby simplifying the manufacturing process of the micro pump and saving the manufacturing process costs.

[0120] While the present invention has been shown and described in connection with the embodiments, it will be apparent to those skilled in the art that modifications and variations can be made without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A micro pump, comprising:
  - a bottom substrate;
  - a channel forming substrate coupled to the bottom substrate and provided with an inlet into which a fluid is introduced and an outlet through which the fluid is discharged; and
  - a valve integrally formed with the channel forming substrate.
2. The micro pump of claim 1, wherein a first surface of the channel forming substrate is provided with the inlet and the outlet, and
  - a second surface of the channel forming substrate is provided with a pressure chamber that connects the inlet to the outlet.
3. The micro pump of claim 2, further comprising:
  - an actuator formed on the first surface of the channel forming substrate and applying pressure to the pressure chamber.
4. The micro pump of claim 1, wherein the bottom substrate and the channel forming substrate are formed of single crystal silicon or silicon on insulator (SOI).
5. The micro pump of claim 1, further comprising:
  - an upper substrate coupled to the channel forming substrate.
6. The micro pump of claim 5, wherein the upper substrate is provided with a first hole connected to the inlet and a second hole connected to the outlet.
7. The micro pump of claim 1, wherein the valve includes:
  - a thin film member;
  - a first opening and closing member formed by a first cutting line cutting a portion of the thin film member; and
  - a second opening and closing member formed by a second cutting line cutting another portion of the thin film member.
8. The micro pump of claim 7, wherein a length of the first cut off line is longer than that of the second cut off line.

9. The micro pump of claim 7, wherein the first cut off line has a curved shape having a first radius, and

the second cut off line has a curved shape having a second radius.

10. The micro pump of claim 9, wherein the first radius and the second radius have different sizes.

11. A micro pump, comprising:

- a bottom substrate;
- a channel forming substrate coupled to the bottom substrate and provided with an inlet into which a fluid is introduced and an outlet through which the fluid is discharged;
- a vibration substrate coupled to the channel forming substrate; and
- a valve integrally formed with the channel forming substrate.

12. The micro pump of claim 11, wherein a first surface of the channel forming substrate is provided with the inlet and the outlet, and

a second surface of the channel forming substrate is provided with a pressure chamber that connects the inlet to the outlet.

13. The micro pump of claim 12, further comprising:

an actuator formed on the first surface of the channel forming substrate and applying pressure to the pressure chamber.

14. The micro pump of claim 11, wherein the bottom substrate and the channel forming substrate are formed of single crystal silicon or silicon on insulator (SOI).

15. The micro pump of claim 11, further comprising:

an upper substrate coupled to the channel forming substrate.

16. The micro pump of claim 15, wherein the upper substrate is provided with a first hole connected to the inlet and a second hole connected to the outlet.

17. The micro pump of claim 11, wherein the valve includes:

- a thin film member;
- a first opening and closing member formed by a first cut off line cutting off a portion of the thin film member; and
- a second opening and closing member formed by a second cut off line cutting off another portion of the thin film member.

18. The micro pump of claim 17, wherein a length of the first cut off line is longer than that of the second cut off line.

19. The micro pump of claim 17, wherein the first cut off line has a curved shape having a first radius, and

the second cut off line has a curved shape having a second radius.

20. The micro pump of claim 19, wherein the first radius and the second radius have different sizes.

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