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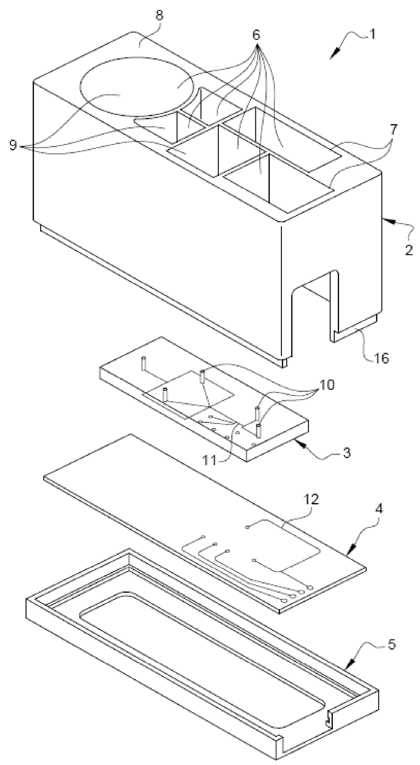
(54) **A DEVICE FOR A MICROFLUIDIC CHIP**

(57) The invention relates to a device suitable for being plugged directly into a microfluidic chip which has at least one opening, the device comprising a body which contains a plurality of independent fluid tanks, wherein each fluid tank has an inlet configured for receiving a fluid and an outlet, forming an open end of the fluid tank and being configured to deliver the corresponding fluid directly into at least one opening of the microfluidic chip, characterized in that each outlet has a smaller opening compared with its corresponding inlet and is configured to be in a sealed fluidic communication with at least one opening of the microfluidic chip.

Fig. 1



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Description

[0001] The present invention relates to the field of microfluidic chips.

[0002] Microfluidic chips enable manipulating and analysing tiny volumes of fluids. Multiple functions can be implemented onto a single chip. It works by utilizing the principles of fluid mechanics to manipulate and control the flow of fluids, typically in the range of microliters or even nanoliters or picoliters.

[0003] Microfluidic chips are often made of materials such as glass, silicon, or polymers, and are designed to accommodate precise and controlled fluid movements. Through a network of interconnected channels and chambers, fluids are directed and guided to perform various tasks, such as mixing, separation, reaction, and analysis.

[0004] Fluids can be introduced into a chip through external sources, such as syringes or pumps, or by capillary action. Valves integrated into the chip can regulate the flow of fluids, allowing for precise control over timing and sequencing of different operations.

[0005] The small dimensions of the channels and chambers in the microfluidic chip leads to advantageous properties, such as laminar flow (where different fluids flow in parallel layers without mixing). More precisely, laminar flow allows the molecules within the fluid to flow, while maintaining their relative positions to one another. These characteristics enable quick and efficient processes within the chip.

[0006] These miniature devices enable precise control over fluids, allowing for many applications in life sciences, biotechnology, chemistry, medical diagnostics, drug discovery, genetic analysis, environmental monitoring, and point-of-care testing.

[0007] Microfluidic chips can be utilized to generate and manipulate water-in-oil droplets (or oil-in-water droplets) with high precision and control formed by microfluidic droplet generators using two immiscible fluids, typically oil and water. The latter consist of microchannels forming junctions or constrictions that allow precise control over the size and frequency of droplets formed. The two immiscible fluids are introduced into the microfluidic chip through separate inlets, and they flow through a network of channels onto the chip. The key component in generating and manipulating droplets within microfluidic chips is the presence of specialized structures called microfluidic droplet generators, the appropriate physicochemistry property of the channel walls, and the appropriate flow rate and/or pressure regime. This technique is often referred to as droplet-based microfluidics or multiphase microfluidics.

[0008] Once the droplets are formed, they can be transported and manipulated within the chip using various techniques. External forces, such as electrical fields, magnetic fields, or pneumatic pressures, can be applied to move, merge, split, or sort the droplets. The manipulation of droplets can be achieved by altering the flow rates, applying electric potentials, or actuating valves within the chip.

[0009] When the two fluid streams meet at specific junctions within the chip, they break up into droplets due to shear forces, surface tension and flow dynamics. The emulsion droplets can be stabilized by surfactants dispersed initially within the aqueous and/or the oil phase (also known as the continuous phase). Surfactants form an interface around the droplets to prevent them from coalescence. These stabilizing agents reduce the interfacial tension between the immiscible phases and favor the creation of interfaces.

[0010] Once the emulsion is formed, it can be further manipulated within the microfluidic chip. It is also possible to merge, split or sort droplets based on their properties. This can be achieved by controlling flow rates, applying electric or magnetic fields, or actuating valves within the microfluidic chip.

[0011] Microfluidic technology has the advantage that small amount of sample is used. This allows reducing reagent consumption.

[0012] Depending on the specific experiments being conducted, the operator may require all modules or only a subset of them, along with varying numbers of reservoirs.

[0013] Liquid introduction into a microfluidic chip can be accomplished through various methods.

[0014] Liquid flow rates within a microfluidic chip can be generated thanks to various methods. For example, syringe pumps can impose a flow rate of the liquids within the microfluidic chips, while pressure pumps and pressure regulators can impose a pressure on the fluid reservoirs.

[0015] Pressure-driven flow is a method consisting of using external pressure sources, such as pressure regulators. This applies positive or negative pressure to fluid reservoirs connected to the inlets of the chips. Thanks to the provided pressure, fluid passes into the microfluidic channels.

[0016] There also exists capillary action method - the liquid is drawn into the microfluidic channels due to capillary forces.

[0017] Furthermore, skilled person also knows electrokinetic methods which needs electric field to be applied to the liquid (e.g., electrophoresis and electroosmosis). The idea is to induce flow within the microfluidic channels. Electroosmosis involves the movement of liquid due to the interaction between the electric field and charged surfaces in the chip.

[0018] It can also be convenient to use the on-chip reservoirs which are connected to the chip and wherein the integrated reservoirs can be filled with liquid manually or through external tubing (or pipetting). These reservoirs act as fluid sources, and the liquid is then introduced into the chip by actuating pressure or eventually by opening and closing appropriate valves.

[0019] Reservoirs are one of the key elements in microfluidic technologies. It serves as storing device and supplying device when introduced into the microfluidic channels.

[0020] Typically, reservoir can be an external (separated) part of the microfluidic chip or integrated onto the chip.

[0021] External fluid handling systems do not have integrated reservoirs on the chip. These are separate containers or vials that hold the liquid to be introduced into the chip. External reservoirs can be connected to the inlets of the chips via tubing, and the liquid can be driven into the microfluidic channels through pressure-driven flow or syringe pump, or other suitable methods. These are more complex, less handy for the user and less efficient when used continuously.

[0022] Integrated-on-chip reservoirs are tiny or large and directly in contact with the chip itself. These reservoirs are typically designed as chambers or wells located near the inlets or specific regions of the chip. They can be filled with the desired liquid manually using pipettes or through external tubing connected to larger fluid reservoirs. The reservoir is not always stably maintained on the chip which can be difficult to manage during conducting experiments.

[0023] With external reservoirs, tubing is used to drive the liquids in the microfluidic channels. Those tubing are creating important dead-volume sometimes more than 10-100 or even 1000-fold the volume of the microfluidic channels.

[0024] When particles are in suspension in the fluids (cells, microbeads, etc), they can sediment within the reservoirs or the tubing. Usually, the tubing is curved from the reservoir to the microfluidic chip inlet which is typically on top of the chip, sedimentation can occur on both side of the curve, causing inhomogeneity in the fluid sample arriving in the channels.

[0025] Moreover, the compliance of the tubing can have a capacitive effect on the fluid priming, causing increased priming time and response time in the fluid and the droplet manipulation.

[0026] Tubing causes dead volumes, capacitive effect and also air bubbles when the tubing is not filled with the fluids at priming.

[0027] Dead volumes and air bubbles present in the tubing initially before priming can make the priming of the microfluidic channels difficult because of pressure jumps generated by the compressibility of pressurized air bubbles. In these conditions, priming can be long (in the scale of minutes), and samples can be wasted during this priming. Whereas with integrated reservoirs, the priming is instantaneous and the dead volume is almost null.

[0028] Tubing can also become disconnected, be torn off, or be pushed in in a non-reproducible manner, more or less deeply.

[0029] Current systems are not ready since they have several limitations when used with multiple reservoirs with the purpose of storing different fluids efficiently.

[0030] More precisely, there are space constraints since microfluidic chips are compact per se which render the use of multiple reservoir complex, resulting in the use of minimum number of reservoirs.

[0031] Manufacturing multiple reservoirs into a microfluidic chip can be more complex - use of several channels, valves, or structures. This complexity can increase the cost and time required for chip fabrication.

[0032] Fluid cross-contamination can be sometimes difficult to avoid with current systems during priming because of the non-deterministic priming with tubing.

[0033] There is therefore a need to provide a device which includes several reservoirs (fluid tanks), while providing user-friendly workspace, reproducibility of the fluidic connection, zero dead volume at the inlet and at the outlet, instant priming, mitigated risk of contamination or fluid loss, smooth manipulation of the device in a continuous and reliable way.

[0034] The present invention provides an efficient and reliable device which includes several reservoirs (fluid tanks) which can be directly plugged into the microfluidic chip, while ensuring user-friendly workspace, mitigated risk contamination or fluid loss and smooth manipulation of the device over time.

[0035] The present invention relates to a device suitable for being plugged directly into a microfluidic chip which has at least one opening, the device comprising a body which contains a plurality of independent fluid tanks, wherein at least one fluid tank has an inlet configured for receiving a fluid and an outlet, forming an open end of the fluid tank and being configured to deliver the corresponding fluid directly into at least one opening of the microfluidic chip, characterized in that each outlet has a smaller opening compared with its corresponding inlet and is configured to be in a sealed fluidic communication with at least one opening provided to be connected to a fluidic channel of the microfluidic chip.

[0036] The device can be seen as a reservoir which contains a plurality of independent fluid tanks. The device can be seen as an on-chip device since it can be directly plugged into a microfluidic chip having at least one opening for a fluid, preferably 2 openings.

[0037] When n fluid tanks have each one outlet, it is foreseen that the microfluidic chip will comprise n openings, which will be ready to have sealed fluidic communication with their corresponding outlets of the respective fluid tanks which latter outlets will be directly plugged into the openings of the chip. And this principle can be repeated depending on the number of fluid tanks in the device. Of course, some tanks of the body can be dead-end tanks without outlets, for example, serving as buffer tanks.

[0038] The main advantage of the present invention relies on the fact that it can be directly connected in a sealed manner to a microfluidic chip. With the device of the present invention, the user can benefit from having several fluid containers configured to deliver a fluid within a microfluidic chip.

[0039] This enables ensuring a continuous process with an efficient device.

[0040] While the device of the present invention comprises several fluid tanks, it still confers a workspace which will be easily managed by the user.

[0041] According to the present invention, it is also contemplated that the outlet of the tank is also directly connected to the chip outlet without tubing, avoiding dead volume of the processed sample. For the droplets, it is an important advantage as the droplets are usually floating on top of the oil: when they come out of the chip, the droplets immediately go to the outlet reservoir on top of the oil, instead of being carried within tubing, where they can accumulate in tubing "elbow" or tubing bend, and are difficult to retrieve afterwards. This is especially important for sorted droplets that can represent a very small volume to collect: sometimes less than 1.000 or even less than 100 droplets of 50 pL sorted and collected, which is less than a microliter. The integrated reservoir at the outlet makes the collection of small amount of droplets and/or cells easier and avoid loosing them in tubings (no dead volume at the outlet).

According to the present invention, this device has advantages in industrialization while remaining flexible/-agile in the microfluidic chip design.

This device can be fabricated at high volumes with industrial manufacturing method : hot embossing, injection molding, etc with the advantage to produce volumes of pieces at low price, with very smooth surfaces in the reservoirs to avoid sample loss (cells, particles, proteins), while the microfluidic chip can be fabricated at lower volume with rapid prototyping manufacturing method (for example soft lithography, polymer or elastomer molding, ...), The channels within the chips can be modified, while the inlets and outlets have to keep the same layout aligned with the outlets of the reservoir device.

[0042] Preferably, the majority of the plurality of the fluid tanks are arranged to be connected to corresponding openings on the chip.

[0043] Advantageously, at least one outlet is configured to be directly plugged into said at least one opening of the microfluidic chip for delivering a fluid, preferably at least 2 of the plurality of independent fluid tanks are configured to be directly plugged into said corresponding at least 2 openings of the microfluidic chip for delivering a fluid.

[0044] Preferably, at least 2 of said plurality of fluid tanks have different internal volume with respect to each other for containing a fluid, more preferably at least 3 of said plurality of fluid tanks have different internal volume with respect to each other. This enables a better configuration of the fluid tanks when plugged into a microfluidic chip which is efficient in terms of the number of fluid tanks which can be connected.

[0045] More preferably, at least one of the outlets is configured to enable the collection of a part of the fluid(s) which has circulated into the chip, eventually part of a mixture of fluids obtained after circulation of the fluids into the chip. This way, it is also possible to use the device of the invention as a collection device wherein one of the fluid tanks acts as a collection and, eventually removal of a part of the fluid or fluids introduced into the microfluidic chip. This means that if the fluids react then the resulting product can be recovered in one of the fluid tanks. More precisely, when the fluid is introduced into the microfluidic chip via one inlet of a given fluid tank then another fluid tank will act as a collection tank meaning that the fluid will reach the outlet of the collection tank in order to be maintained within that collection tank.

[0046] Advantageously, said body is a casing having lateral walls and one upper face. From the upper face, tanks extend internally. The body can be molded as a monobloc molded body, with some hollow portions between external faces of the tank and the internal faces of the casing. Of course, this design is particularly suitable for being molded with an amount of plastic or polymer material that is optimized to be as low as possible. In a variant, the room between the external faces of the tank and the internal faces of the casing is plain. While requiring a higher amount of plastic or polymer for the molded body, the body will have a stronger resistance which can be useful for some applications. In both cases, the plurality of independent tanks is a physical and nonremovable part of the body of the device.

[0047] More advantageously, said device contains at least one upper face on which each inlet of said body is located and wherein each inlet corresponds to an open end of the corresponding fluid tank. In this configuration, it is possible that some or all the inlets of the fluid tanks extends beyond that upper face or are defined in a plan wherein each of the inlets are contained. Even more preferably, the upper face can be planar.

[0048] Preferably, at least 2 of said plurality of fluid tanks have identical internal volume with respect to each other for containing a fluid, more preferably at least 3 of said plurality of fluid tanks have identical internal volume with respect to each other, more preferably at least 4 of said plurality of fluid tanks have identical internal volume with respect to each other.

[0049] According to a preferred embodiment of the invention, each inlet has a section, eventually selected in the group comprising circular section, rectangular section, square section, triangular section, section containing more than 3 angles and combinations thereof.

[0050] Each of the plurality of independent fluid tanks preferably has an internal surface configured to leave the corresponding fluid flowing along it with a minimum of it remaining on said internal surface, preferably the material of the internal surface is low surface tension plastic and/or hydrophobic material. This can take the form of a plastic or polymer or metal having a very smooth surface, low roughness surface, hydrophobic surface or low surface tension.

[0051] In a preferred embodiment, the device of the present invention contains securing means which are arranged to fix said device to said microfluidic chip.

[0052] Preferably, each corresponding inlet of the body is configured to be in a sealed fluidic communication with a plurality of fluid connectors which are connected to delivering means, preferably pressurizing means, for enabling passage of the fluid from the reservoirs into the microfluidic chip.

[0053] More preferably, each fluid tank has a first part and a second part, wherein the first part has a volume which is higher than the volume of the second part, preferably each fluid tank has the shape of a funnel or cone or convergent surface avoiding corners where fluid or sample (cells, molecules, particles) can stagnate. Alternatively, each fluid tank can have a continuous shape like a funnel with a progressive reduction of its circumference.

[0054] Advantageously, at least two of said plurality of independent fluid tanks are each configured to deliver a fluid into a corresponding opening of the microfluidic chip. According to a preferred embodiment, there are at least 2 fluid tanks acting as delivering fluid into the microfluidic chip and at least 1 fluid tank which acts as a collection tank. Even more preferably, at least 2 fluid tanks act as delivering fluid into the microfluidic chip and at least 2 fluid tanks act as collection tanks.

[0055] More advantageously, the device of the invention can comprise at least one visualization zone. A visualization zone is an area in which light travels freely without distortion, e.g., a flat, transparent surface. Such a visualization zone makes it possible to observe the progress of the microfluidic experiment within the microfluidic chip.

[0056] Said visualization zone can be imaged, observed for example through a microscope objective, a camera, and illuminated thanks to a transmission or reflected light. It can also serves as an optical detection zone, for exemple for fluorescence, absorbance, or light scattering measurement. Photodetectors and exciting light can go through the visualization zone.

[0057] According to a preferred embodiment, the present invention also claims a device wherein said body is arranged to cover the entire surface of the microfluidic chip.

[0058] According to a particularly preferred embodiment, said planar surface of the device is arranged to entirely cover the microfluidic chip.

[0059] In one advantageous embodiment of the invention, the body of the device of the invention is a one-piece device, preferably onemolded body.

[0060] The device can have at least two pieces, at least one for the body and one for a cap sealing the body with inlet connectors (for sample injection, pipetting and for pressurizing). The cap sealing the body can be the aforementioned upper face as a separated piece of the device or an additional cap covering the upper face of the device.

[0061] In a variant embodiment, the device consists of 2 pieces, preferably 3 pieces. More precisely, the first piece is the body, the second is the cap, the third is in the form of a bottom cover which is placed below the device. This way, the microfluidic chip can be maintained within the casing formed of the aforementioned 3 pieces of the device of the invention.

[0062] Preferably, the device of the invention comprises a plurality of fluid connectors which are in a sealed fluidic communication with each corresponding inlet of the body, arranged to deliver the fluid into the microfluidic chip and to collect fluid out of the chip and configured to be connected to pressurization means for enabling delivery of the fluid into the microfluidic chip.

[0063] In an advantageous embodiment, the device of the invention comprises a cover containing a plurality of fluid connectors which are in a sealed fluidic communication with each corresponding inlet of the body, arranged to deliver the fluid into the microfluidic chip and configured to be connected to pressurization means for enabling delivery of the fluid into the microfluidic chip.

[0064] Advantageously, each fluid tank has a storage volume of at least 100 μL, preferably comprised between 10 μL and 10 mL.

[0065] More advantageously, the device of the invention comprises at least 2 fluid tanks, preferably at least 3 fluid tanks, more preferably at least 4 fluid tanks.

[0066] In a particular embodiment, said planar surface of the device can extend vertically forming at least 2, preferably 4, vertical walls surrounding said plurality of independent fluid tanks. It can be seen as casing containing the fluid tanks.

[0067] Other embodiments of the device according to the present invention are mentioned in the appended claims.

[0068] The present invention also concerns a microfluidic product which comprises the device according to the present invention and a microfluidic chip, which comprises an internal microchannel network for a fluid and a plurality of openings.

[0069] Advantageously, the microfluidic product further contains one electrode or several electrodes.

[0070] In a preferred embodiment, the microfluidic chip rests on one electrode, which is laying on the bottom cover. The Body of the microfluidic product according to the present invention than cover the microfluidic chip and the electrode.

[0071] Preferably, the body contains lateral walls forming a casing. The lateral walls preferably comprise a connection means, located in the bottom portion of the lateral walls, provided to ensure the connection with the bottom cover of the device. The connection means can be a shoulder allowing the insertion of the bottom end of the lateral walls inside the walls of the bottom cover. Alternatively, the connection means can be any connection means to be engaged into additional connections means beared by the bottom cover.

[0072] The device comprises a body which contains a plurality of independent fluid tanks, wherein each fluid tank has an inlet configured for receiving a fluid and an outlet, forming an open end of the fluid tank and being configured to deliver the corresponding fluid directly into at least one opening of the microfluidic chip, characterized in that each outlet has a smaller opening compared with its corresponding inlet and is configured to be in a sealed fluidic communication with at least one opening of the microfluidic chip.

[0073] Within the meaning of the present invention, the term outlet expresses an open end of the fluid tank in fluid communication with the microfluidic chip. In the present description, the fluid tanks have been mainly described as reservoir of fluid. Of course, in some cases the fluid tanks can be used as reservoir for collection and accordingly an outlet can have a role of inlet and an inlet can have a role of outlet.

[0074] Within the meaning of the present invention, the term inlet expresses an opening for receiving a fluid to be contained in the fluid tanks. In the present description, the fluid tanks have been mainly described as reservoir of fluid. Of course, in some cases the fluid tanks can be used as reservoir for collection and accordingly an inlet can have a role of outlet and an outlet can have a role of inlet.

[0075] Preferably, the microfluidic product contains a plurality of fluid connectors which are in a sealed fluidic communication with each corresponding inlet of the body and configured to be connected to delivering means, preferably pressurizing means, for enabling passage of the fluid into the microfluidic chip.

[0076] More preferably, at least one of the outlets is configured to enable the collection of a part of the fluid which has circulated into the chip, eventually part of a mixture of fluids obtained after circulation of the fluids into the chip.

[0077] Even more preferably, said plurality of fluid connectors are part of a cover which extends above all said plurality of independent fluid tanks.

[0078] Other embodiments of the microfluidic chip of the present invention are mentioned in the appended claims.

[0079] Reservoirs in microfluidic chips are important for maintaining a continuous and controlled supply of fluids throughout the experiment. They enable precise timing and delivery of liquids, facilitating experiments involving mixing, reactions, and analysis within the microfluidic channels. Reservoirs can be designed to accommodate different volumes, and their integration into microfluidic chips streamlines fluid handling, reduces the risk of contamination, make possible to work with small sample volume and collection of small amount of processed sample, without dead volume.

[0080] Fluid tanks are storage to store fluids. Fluid is a substance that has no fixed shape and yields easily to external pressure. A fluid can be a gas, a liquid, a combination of gas, a combination of liquid or a combination of gas and liquid. For example, a mixture of oil and water is a fluid.

[0081] The present invention also claims a microfluidic product wherein each opening dedicated to fluid transfer is configured for being in a sealed fluidic communication with its corresponding output of the fluid tank.

[0082] The present invention also claims a microfluidic product further comprising an electrode or several electrodes or active means for fluid processing (valves, ...).

[0083] Other characteristics and advantages of the present invention will be derived from the non-limitative following description, and by making reference to the drawings and the examples.

[0084] In the drawings, figure 1 is an exploded view of a microfluidic product containing the device according to the invention, a microfluidic chip and an electrode.

Figure 2 is a view from the top of a device according to the invention.

Figure 3 is a view from the bottom of a device according to the invention.

Figure 4 is a cross-section view of a device according to the invention.

[0085] In the drawings, the same reference numbers have been allocated to the same or analog element.

Detailed description.

[0086] Fig. 1 shows an exploded view of a Microfluidic product **1** comprising one body **2**, a polymer microfluidic chip **3**, an electrode plate **4** on which conductive part **12** are located, a bottom cover **5.** Commonly microfluidic chip is comprised of a polymer microfluidic chip 3 forming the chip top and a bottom electrode plate 4 or a glass plate, sometimes called chip bottom.

[0087] The body **2** contains several independent fluid tanks **6,** forming a series or a plurality of fluid tank(s) **6.** According to the present invention, at least one tank **6** has an inlet **7** and an outlet **13** (see figure 3). In the illustrated embodiment, each fluid tank has one inlet **7** and one outlet **13** (see figure 3). Fluid tanks **6** are configured to receive fluids coming from their inlet **7** or outlet. Inlets **7** are typically open-end abutting through the upper face **8** of the body **2** and are configured for receiving a fluid and feeding said tank **6.** In a variant embodiment, the open end (inlet **7**) of the tank **6** extend over the upper face **8** and can be covered by a cap, for example a screwed cap or a clicked cap. In this embodiment, at least 2 fluid tanks **6** have a different internal volume with respect to each other. In this embodiment, at least 2 fluid tanks **6** have an identical internal volume with respect to each other for containing a fluid. In this embodiment, some inlets **7** have a rectangular section while some inlets **7** have a section containing 3 angles or more than 3 angles. One of the inlets has a circular section. Needless to be said that the section of the inlet can have any shape and that the plurality of inlet can have any combination of the aforementioned sections. Preferably, the internal surface **9** of the tanks **6** is configured to leave the corresponding fluid flowing along it with a minimum of it remaining on said internal surface **9.** Preferably the internal surface **9** is made in a material such as low surface tension plastic and/or hydrophobic material. Each inlet **7** is configured to be in a sealed fluidic communication with a plurality of fluid connectors (not visible), such as Luer connectors, which are connected to delivery means (not visible), preferably pressuring means (not visible), for enabling passage of the fluid into the polymer microfluidic chip **3.**

[0088] The polymer microfluidic chip **3** of the microfluidic product has several openings **10**, those openings allow the passage of fluids through them. At least one opening **10** is configured to be in a sealed fluidic communication with an outlet of a tank **6**, but preferably each opening **10** is configured to be in a sealed fluidic communication with one outlet **13** of a tank. Some of the openings **10** are in fluid communication with a fluidic channel **11** of the polymer microfluidic chip **3.**

[0089] The electrode plate **4** of the microfluidic product contains conductive parts **12** configured to conduct electricity in order to perform experiments, such as separation, sorting, selection, etc.

[0090] The bottom cover **5** of the microfluidic product is configured to hold the electrode plate **4** and/or the polymer microfluidic chip **3.**

[0091] The body **2** is connected to the polymer microfluidic chip **3** via its outlets **13** which are configured to be in a sealed fluidic communication with at least one opening **10** of the polymer microfluidic chip **3.** At least one outlet **13** is configured to be directly plugged into at least one opening **10** of the polymer microfluidic chip **3** for delivering a fluid.

[0092] The electrode plate **4** is configured to support the polymer microfluidic chip **3.**

[0093] The bottom **5** is configured to accommodate the electrode plate **4** and/or the polymer microfluidic chip **3** and is configured to connect to the body **2** to give structural strength to the device **1**, such as through connection means, such as a shoulder **16** provided in the bottom part of the lateral walls of the body **2.**

[0094] Fig. 2 shows a view from the top of a device **1** according to the invention. In this embodiment, the body **2** has a casing having lateral walls and one upper face **8** having openings corresponding to the inlets of the tanks.

[0095] Fig. 3 shows a view from the bottom of a device **1** according to the invention. In this embodiment, the body **2** contains a plurality of independent fluid tanks **6.** Each fluid tanks **6** has an outlet **13** forming an open end of the fluid tank **6** and being configured to deliver the corresponding fluid. Each outlet **13** has a smaller opening compared with its corresponding inlet **7.** In this embodiment, at least one of the outlets **13** is configured to enable the collection of a part of the fluid which has circulated into the chip.

[0096] Fig. 4 shows a cross-section view of a device 1 according to the invention. In this embodiment, the device **1** consists of a body **2.** Each fluid tanks **6** has an inlet **7** and an outlet **13.** Each outlet **13** has a smaller opening compared with its corresponding inlet **7.** Each fluid tank has a first part **14** and a second part **15.** The first part **14** has a volume which is higher than the volume of the second part **15.** In this embodiment, fluid tanks **6** have the shape of a funnel.

Claims

1. A device suitable for being plugged directly into a microfluidic chip which has at least one opening, the device comprising a body which contains a plurality of independent fluid tanks, wherein at least one fluid tank has an inlet configured for receiving a fluid and an outlet, forming an open end of the fluid tank and being configured to deliver the corresponding fluid directly into at least one opening of the microfluidic chip, **characterized in that** each outlet has a smaller opening compared with its corresponding inlet and is configured to be in a sealed fluidic communication with at least one opening provided to be connected to a fluidic channel of the microfluidic chip.

2. Device according to claim 1, wherein at least one outlet is configured to be directly plugged into said at least one opening of the microfluidic chip for delivering a fluid, preferably at least 2 of the plurality of independent fluid tanks are configured to be directly plugged into corresponding at least 2 openings of the microfluidic chip for delivering a fluid.

3. Device according to claim 1 or 2, wherein at least one of the outlets is configured to enable the collection of a part of the fluid(s) which has circulated into the chip, eventually part of a mixture of fluids obtained after circulation of the fluids into the chip.

4. Device according to any one of the preceding claims, wherein said device contains at least one upper face on which each inlet of said body is located and wherein each inlet corresponds to an open end of the corresponding fluid tank.

5. Device according to any one of the preceding claims, wherein each inlet has a section, eventually selected in the group comprising circular section, conical section, rectangular section, square section, triangular section, section containing 3 or more than 3 angles and combinations thereof.

6. Device according to any one of the preceding claims, wherein each of the plurality of independent fluid tanks has an internal surface configured to leave the corresponding fluid flowing along it with a minimum of it remaining on said internal surface, preferably the material of the internal surface is low surface tension plastic and/or hydrophobic material.

7. Device according to any one of the preceding claims, wherein said device contains securing means which are arranged to fix said device to said microfluidic chip.

8. Device according to any one of the preceding claims, wherein each corresponding inlet of the body is configured to be in a sealed fluidic communication with a plurality of fluid connectors which are connected to delivering means, preferably pressurizing means, for enabling passage of the fluid into the microfluidic chip.

9. Device according to any one of the preceding claims, wherein each fluid tank has a first part and a second part, wherein the first part has a volume which is higher than the volume of the second part, preferably each fluid tank has the shape of a funnel.

10. Device according to any one of the preceding claims, wherein at least 2 of said plurality of independent fluid tanks are each configured to deliver a fluid into a corresponding opening of the microfluidic chip.

11. Microfluidic product comprising the device according to any one of the preceding claims and a microfluidic chip comprising an internal microchannel network for a fluid and a plurality of openings, wherein the device comprises a body which contains a plurality of independent fluid tanks, wherein each fluid tank has an inlet configured for receiving a fluid and an outlet, forming an open end of the fluid tank and being configured to deliver the corresponding fluid directly into at least one opening of the microfluidic chip, **characterized in that** each outlet has a smaller opening compared with its corresponding inlet and is configured to be in a sealed fluidic communication with at least one opening of the microfluidic chip.

12. Microfluidic product according to claim 11, comprising a plurality of fluid connectors which are in a sealed fluidic communication with each corresponding inlet of the body and configured to be connected to delivering means, preferably pressurizing means, for enabling passage of the fluid into the microfluidic chip.

13. Microfluidic product according to claim 11 or 12, wherein at least one of the outlets is configured to enable the collection of a part of the fluid which has circulated into the chip, eventually part of a mixture of fluids obtained after circulation of the fluids into the chip.

14. Microfluidic product according to any one of the claims 11 to 13, wherein said plurality of fluid connectors are part of a cover which extends above all said plurality of independent fluid tanks.

Fig. 1

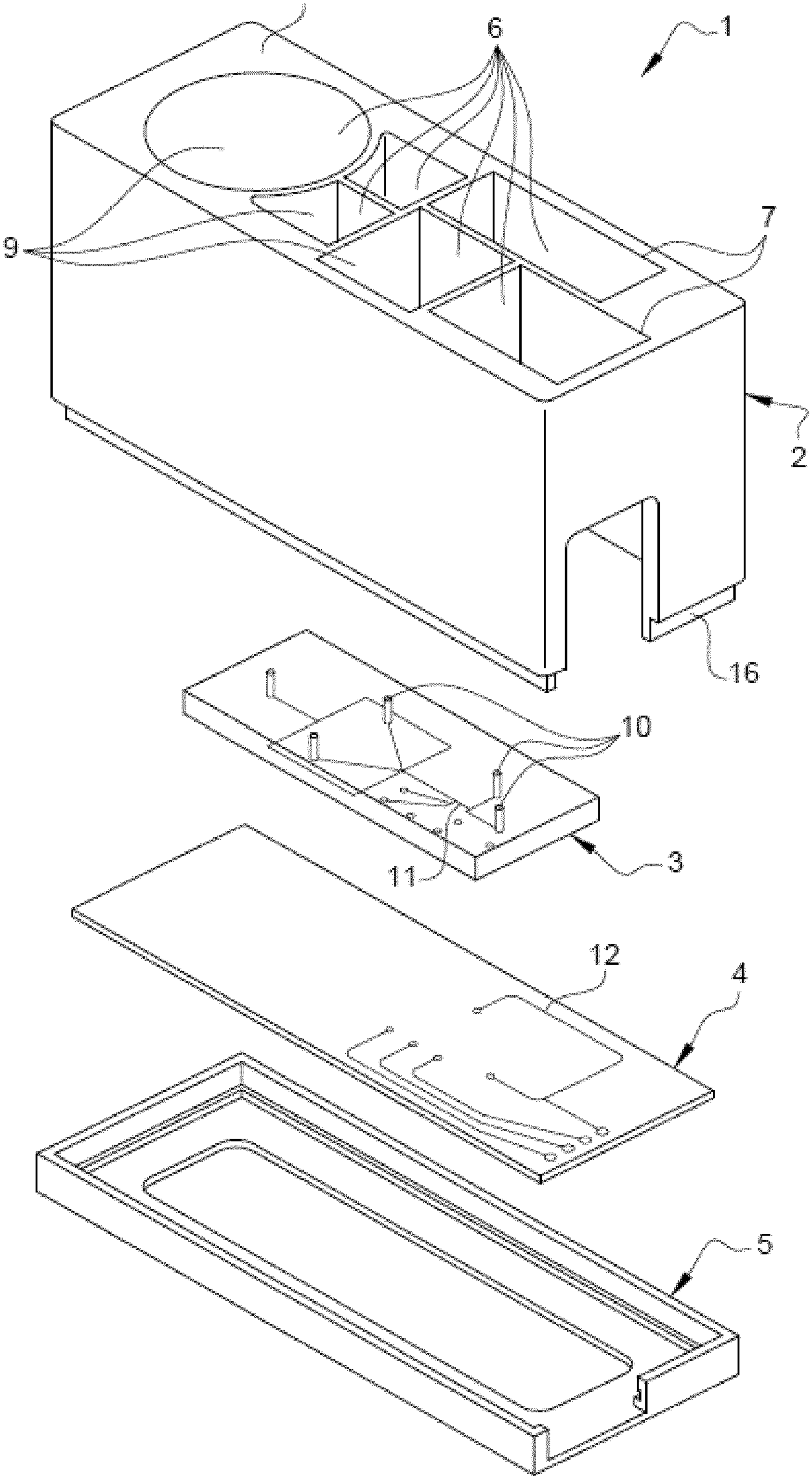


Fig. 2

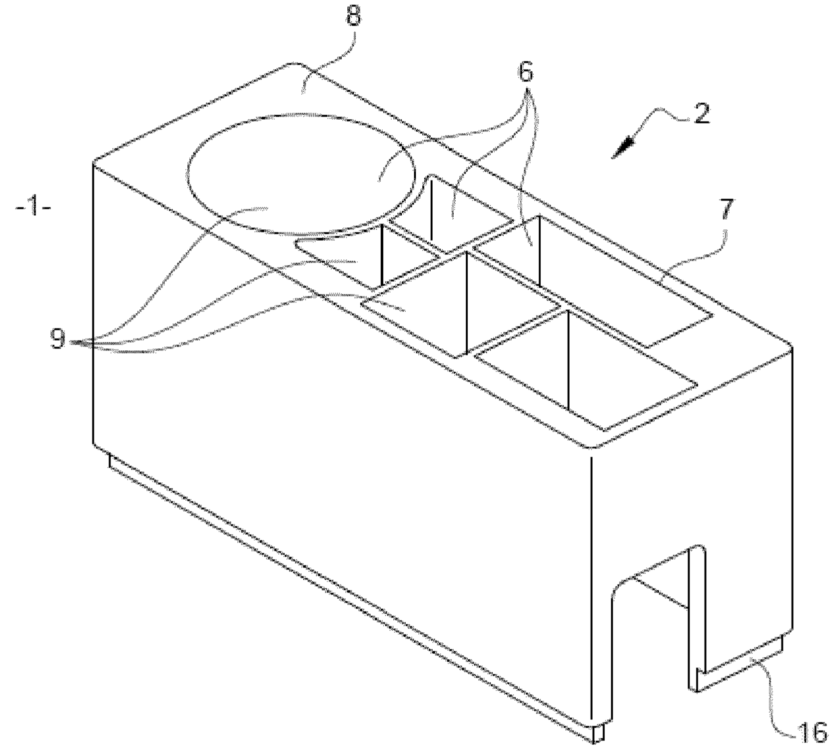


Fig. 3

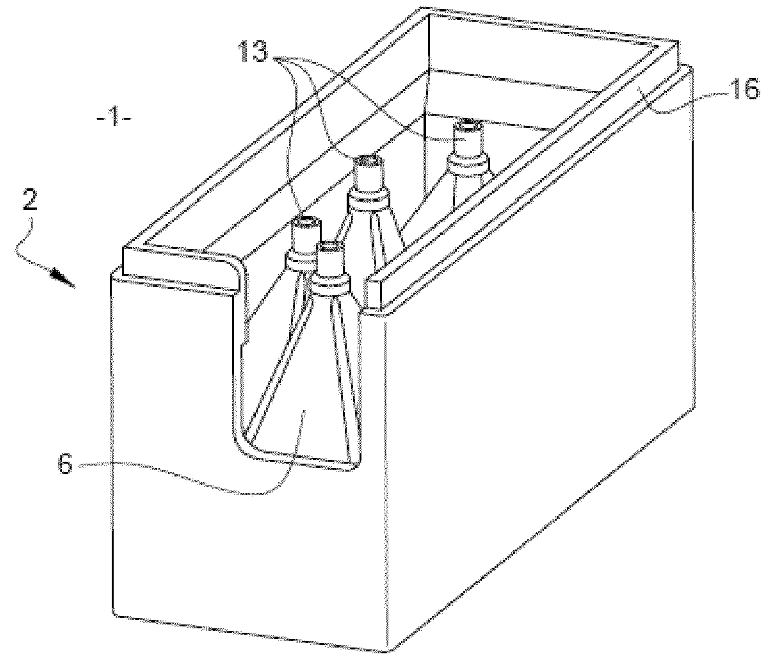
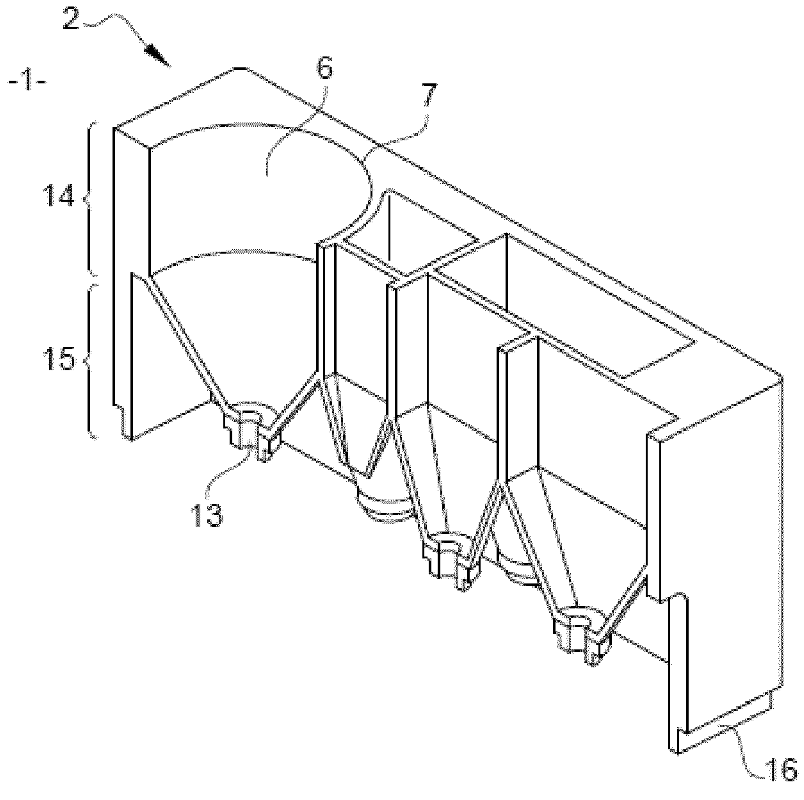


Fig. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 4471

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2011/008223 A1 (TSAO RAY [US] ET AL) 13 January 2011 (2011-01-13) * paragraphs [0072], [0075], [0076], [0080] - [0090], [0130]; figures 5-15 * -----	1-13 14	INV. B01L3/00
X Y	US 2019/201899 A1 (CEREDA MARCO [IT] ET AL) 4 July 2019 (2019-07-04) * paragraphs [0219] - [0250], [0345], [0361]; figures 31,32 * -----	1-13 14	
X Y	US 2022/410150 A1 (CHO YOUNG-SHIK [KR] ET AL) 29 December 2022 (2022-12-29) * paragraphs [0091], [0097]; figures 4,9 * -----	1-13 14	
Y	GB 2 601 649 A (EMULATE INC [US]) 8 June 2022 (2022-06-08) * figure 1 * -----	14	
A	JP 4 464317 B2 (HITACHI IND CO LTD; ENPLAS CORP; ASAHI RUBBER KK) 19 May 2010 (2010-05-19) * the whole document * -----	1-14	TECHNICAL FIELDS SEARCHED (IPC) B01L

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	16 January 2024	Vahidpour, Farnoosh

CATEGORY OF CITED DOCUMENTS

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16-01-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011008223 A1	13-01-2011	US 2011008223 A1	13-01-2011
		US 2013224845 A1	29-08-2013
		US 2015111289 A1	23-04-2015
		US 2016074864 A1	17-03-2016
		WO 2010118427 A1	14-10-2010
US 2019201899 A1	04-07-2019	CN 109967139 A	05-07-2019
		CN 209836141 U	24-12-2019
		EP 3505255 A1	03-07-2019
		US 2019201899 A1	04-07-2019
		US 2023058091 A1	23-02-2023
US 2022410150 A1	29-12-2022	EP 4112172 A1	04-01-2023
		KR 102346703 B1	04-01-2022
		US 2022410150 A1	29-12-2022
		WO 2023277245 A1	05-01-2023
GB 2601649 A	08-06-2022	AU 2016312678 A1	29-03-2018
		AU 2019272039 A1	19-12-2019
		AU 2020286174 A1	07-01-2021
		BR 112018003614 A2	25-09-2018
		CA 2996000 A1	02-03-2017
		CA 3053745 A1	02-03-2017
		CA 3176776 A1	02-03-2017
		CN 108699504 A	23-10-2018
		CN 114540192 A	27-05-2022
		DK 3341465 T3	20-11-2023
		EP 3341465 A1	04-07-2018
		EP 3656844 A1	27-05-2020
		EP 4026616 A1	13-07-2022
		GB 2544152 A	10-05-2017
		GB 2595786 A	08-12-2021
		GB 2601649 A	08-06-2022
		GB 2601650 A	08-06-2022
		HK 1250739 A1	11-01-2019
		JP 6608043 B2	20-11-2019
		JP 6741826 B2	19-08-2020
		JP 6871972 B2	19-05-2021
		JP 6931434 B2	01-09-2021
		JP 7387681 B2	28-11-2023
		JP 2018525022 A	06-09-2018
		JP 2019136046 A	22-08-2019
		JP 2019136047 A	22-08-2019
		JP 2021101746 A	15-07-2021
		JP 2021175416 A	04-11-2021
		JP 2024003181 A	11-01-2024

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 20 4471

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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-01-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		KR 20180042366 A	25-04-2018
		KR 20190090093 A	31-07-2019
		KR 20210064399 A	02-06-2021
		KR 20220066205 A	23-05-2022
		KR 20230026525 A	24-02-2023
		KR 20230164753 A	04-12-2023
		SG 10201811548P A	27-02-2019
		US 2017055522 A1	02-03-2017
		US 2017056880 A1	02-03-2017
		US 2017058243 A1	02-03-2017
		US 2017058248 A1	02-03-2017
		US 2017058257 A1	02-03-2017
		US 2019002811 A1	03-01-2019
		US 2019040348 A1	07-02-2019
		US 2019040349 A1	07-02-2019
		US 2019112566 A1	18-04-2019
		US 2019169557 A1	06-06-2019
		US 2020190455 A1	18-06-2020
		US 2021179992 A1	17-06-2021
		US 2023022203 A1	26-01-2023
		WO 2017035484 A1	02-03-2017
JP 4464317 B2	19-05-2010	AT E523252 T1	15-09-2011
		EP 1721669 A2	15-11-2006
		JP 4464317 B2	19-05-2010
		JP 2006317309 A	24-11-2006
		US 2006257263 A1	16-11-2006

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82