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(54) **DEVICES AND METHODS FOR HOLDING MICROFLUIDIC DEVICES**

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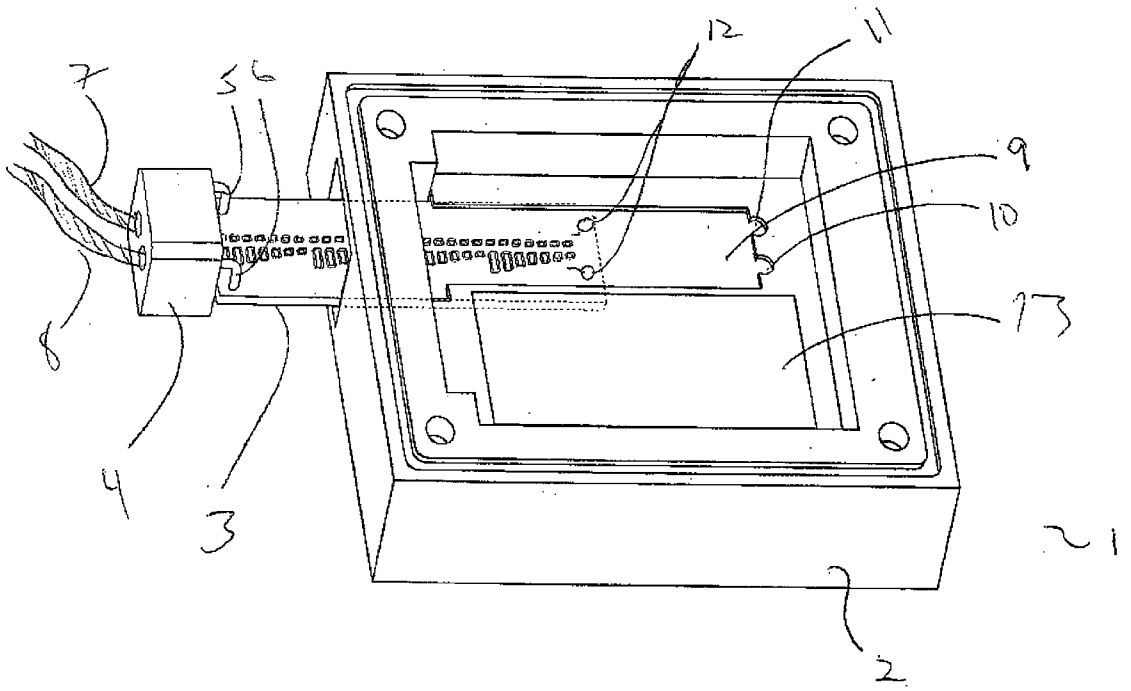
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(57) **ABSTRACT**

Carriers or holders for holding microfluidic devices are provided. Some of the carriers that are provided include a hydration control device and/or a source of controlled fluid pressure to facilitate use of the carrier in conducting various types of analyses.



PRIOR ART

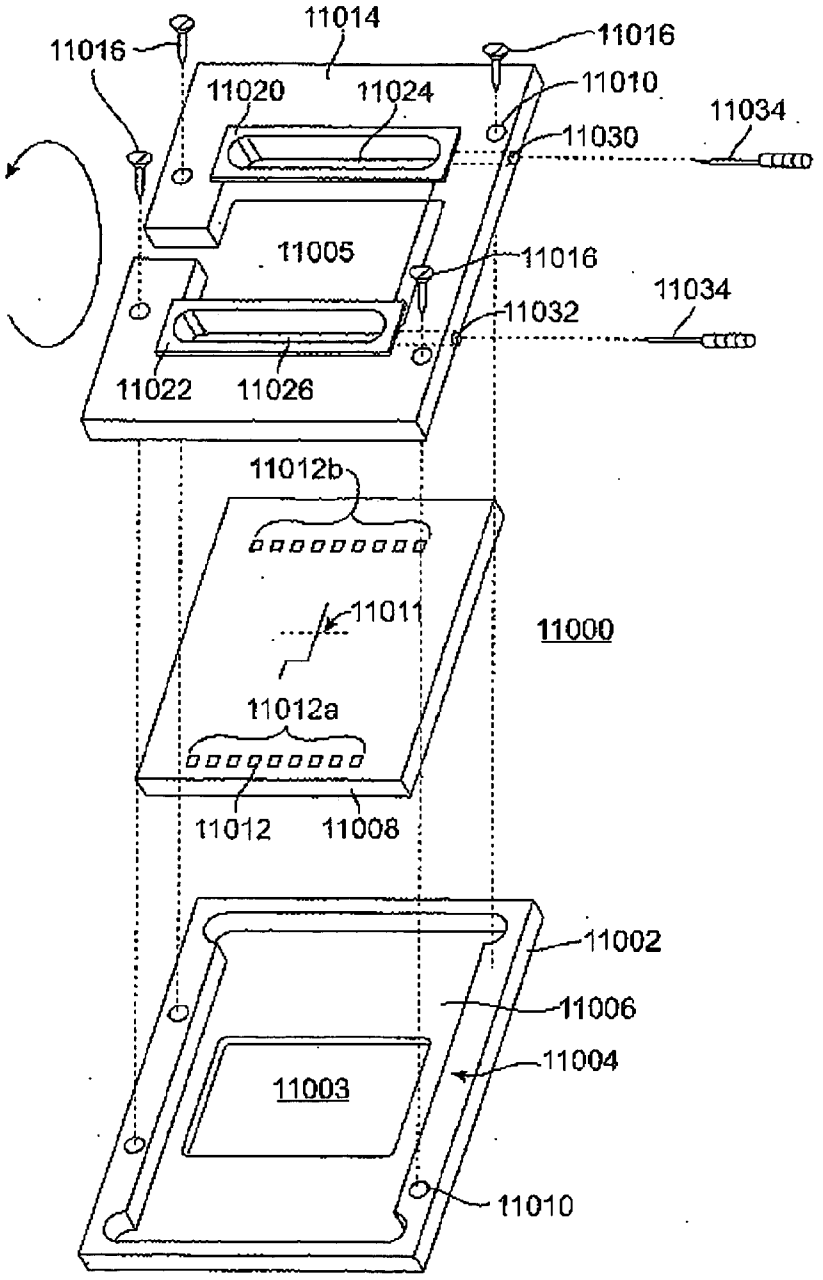


FIG. 1

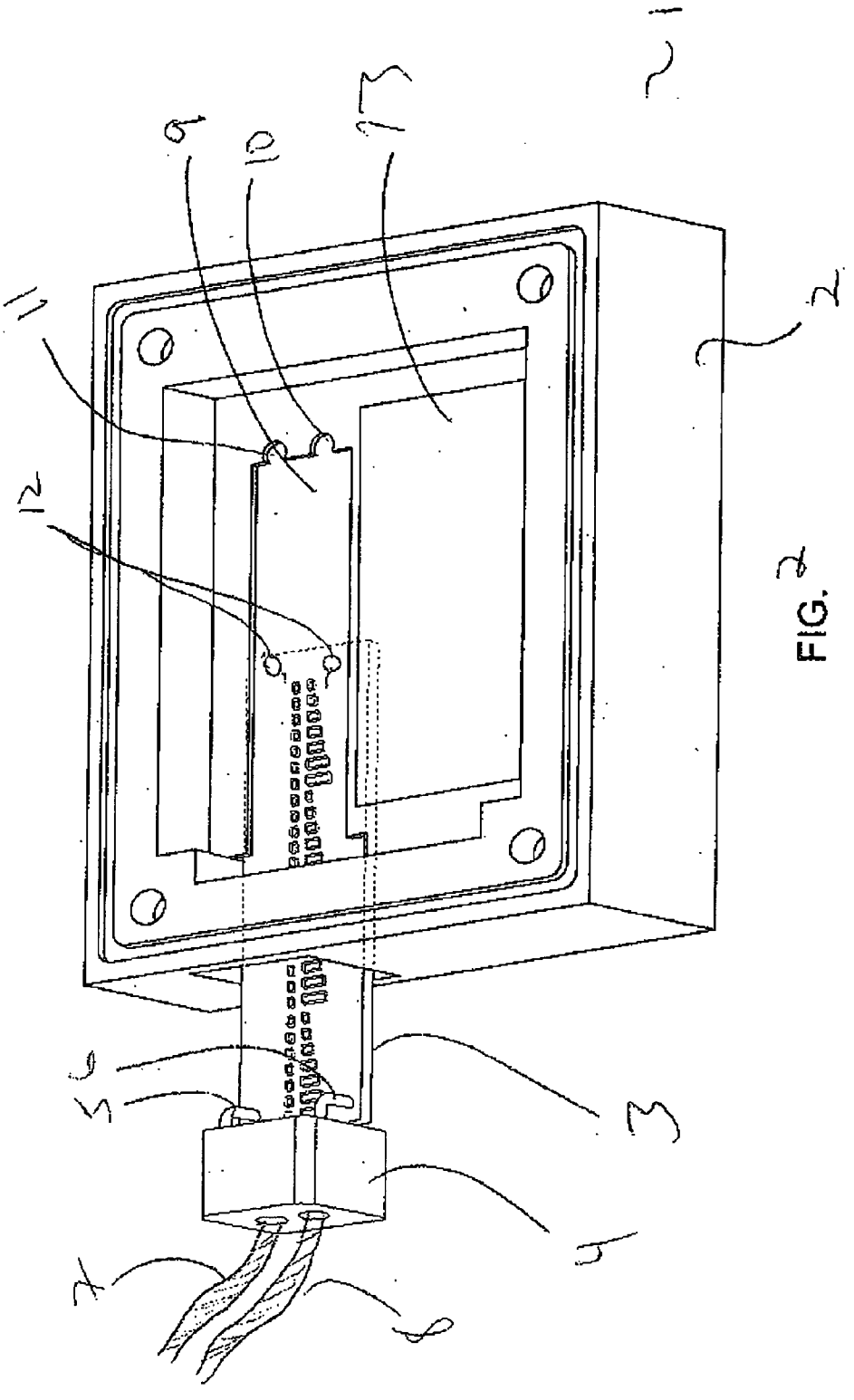


FIG. 2

DEVICES AND METHODS FOR HOLDING MICROFLUIDIC DEVICES

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/525,245, filed Nov. 26, 2003, which is incorporated herein by reference in its entirety for all purposes.

BACKGROUND OF THE INVENTION

[0002] Microfluidic based protein crystallization devices and methods have been described in co-pending U.S. patent application Ser. No. 10/117,978 filed on Apr. 5, 2002, by Hansen, et al., which is herein incorporated by reference in its entirety for all purposes and the specific purpose of teaching microfluidic based protein crystallization devices and methods. Hansen described a carrier for holding the microfluidic devices described by Hansen in which a microfluidic device was placed onto a bottom plate and retained by a top plate.

BRIEF SUMMARY OF THE INVENTION

[0003] The invention provides, in one aspect, for a carrier for holding a microfluidic device comprising: a housing, the housing defining a chamber therein and having a receiving portion for receiving the microfluidic device; a connection block for retaining the microfluidic device, wherein the connection block is attachable to the microfluidic device through one or more prongs, and the microfluidic device, when retained by the connection block, is insertable into the receiving portion of the housing. Other embodiments include having the one or more prongs be two or more prongs, having at least one of the one or more prongs is a tube, having the receiver has at least one slot for guiding and retaining the microfluidic device when inserted into the receiving portion, having the receiver further comprises one or more pipette supports for guiding a pipette tip into the microfluidic device when inserted into the receiving portion, including one or more accumulators for providing fluid under pressure to the microfluidic device when inserted into the receiving portion, preferably where at least one accumulator further comprises a check valve, having the housing comprises a housing base and a housing cover, preferably where an accumulator is attached to the housing, and preferably where the housing cover and the housing base are sealed together by a gasket, including a humidity control material within the housing for providing humidity control, preferably where the humidity control material is selected from the group consisting of a sponge, a gel matrix, a desiccant, and a woven material, having the housing is preferably be made from a polymer, more preferably where the polymer is either polycarbonate or acrylic or polystyrene, preferably where the accumulator is in fluid communication with the connection block through one or more accumulator-connection block tubes, wherein the accumulator-connection block tubes are preferably flexible, having a first tube of the one or more tubes is in communication with the microfluidic device for controlling one or more first valves, preferably wherein a second tube of the one or more tubes is in communication with the microfluidic device for controlling one or more second valves, for example, but not limited to, wherein the first valves are interface valves and/or wherein the second valves are containment valves.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] **FIG. 1** depicts a carrier described in the prior art.

[0005] **FIG. 2** depicts a perspective view of a preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0006] The invention provides for devices, and methods for using such devices, for holding and manipulating microfluidic devices, in particular, multilayer elastomeric microfluidic devices wherein at least one deflectable membrane acts as a valve to interrupt or separate fluid within a microfluidic channel having a cross-sectional dimension of about 500 micrometers. Exemplary microfluidic devices have been described by Hansen, supra, which are used to screen for conditions which cause protein crystals to form from protein solutions by free-interface diffusion (FID). In use, the devices of Hansen are loaded with a protein solution and a crystallization agent, typically in the form of a reagent solution, wherein each solution enters into individual chambers interconnected by a channel having a valve therein. Containment valves are then used to keep each of the solutions in their respective chamber as the valve located in the channel separating the chambers is opened to initiate diffusion between the chambers. In preferred devices of Hansen, the valves are actuated by changes in fluid pressure, for example either hydraulically or pneumatically. Therefore, a means for changing fluid pressure to each of the valve is helpful.

[0007] The invention provides, in one aspect, for a carrier that provides access to controlled fluid pressure. **FIG. 2** depicts a perspective view of a preferred embodiment. The carrier in **FIG. 2**, which preferably has about a three inch square footprint and is preferably about one inch in height, is preferably made from a polymer, preferably acrylic. Other materials may be used depending on the nature of the experiments to be performed using the carrier, and the solvents that the carrier may be exposed to during use. For example, a carrier could be made from polypropylene to provide resistance to certain solvents such as acetone.

[0008] In **FIG. 2**, carrier **1** comprises housing or main block **2**, a carrier lid or cover, not shown, which is used to close of the main block to form a chamber within carrier **1**. Microfluidic device **3**, which may be a microfluidic device or chip used to grow protein crystals, is held by connection block **4** through pins **5** and **6**, which are preferably tubes in communication with flexible tubes **7** and **8**, which in turn are connected to a source of controlled fluid pressure used to actuate valves within the microfluidic device. Microfluidic device **3**, while attached to connection block **4**, is inserted into main block **2** into a receiving portion **9**, which may include at least one slot for retaining microfluidic device **3** while inserted within main block **2**. Once fully inserted, microfluidic device **3** will be situated such that sample and reagent inlets **12** are within positioning guides **11** which are used to help a user to position a pipette tip into the microfluidic device for loading samples and reagents. Hydration control area **13** may further contain a source for hydration such as a sponge, a gel package, or a woven material such as a piece of cloth or a cotton ball/pad.

[0009] In use, a user would insert pins **5** and **6** of connection block **4** into microfluidic device **3**, preferably in to ports

located on the microfluidic device for communicating with valves therein. The microfluidic device would then be inserted into main block **2** to the extent that connection block **4** would contact, preferably mate, with receiving portion **9** of main block **2**. Samples and regents could then be loaded into the microfluidic device before the attachment of a carrier lid or cover, not shown, to main block **2**. Guides **10** and **11** would be used to help guide a pipette tip into the inlet port of the microfluidic device. During loading, it may be desirable to have at least one valve within the microfluidic device be activated so as to separate one or more fluid volumes contained within the microfluidic device. Once loaded, the user would then place carrier cover or lid, not shown, onto main block **2** to form a chamber housing the microfluidic device. A hydration control device, such as a sponge or pad may also be placed within the chamber in region **13**, prior to attaching the cover. The sponge may be hydrated with water, buffer, a crystallization reagent, or a solvent. Alternatively, a desiccating material may added to remove moisture from the microfluidic device.

[**0010**] In preferred embodiments, an accumulator may be added to the carrier to provide a source of controlled fluid pressure. For example, an accumulator chamber may be affixed to the main block or the lid of the carrier, the accumulator chamber being in fluid communication with the connection block, and, therefore, with the microfluidic device. The advantage of having an "on-board" source of controlled fluid pressure is that the microfluidic device, if actuated by changes in fluid pressure, can be kept in an actuated state independent of an external source of fluid pressure, thus liberating the microfluidic device and carrier from an umbilical cord attached to that external source of fluid pressure. In preferred embodiments, the accumulator may further include a check valve for retaining fluid pressure within the accumulator. The accumulator may further include a gas pressurization inlet port, a liquid addition port, and a pressurized fluid outlet for communicating fluid pressure to the connection block.

[**0011**] While the present invention has been described herein with reference to particular embodiments thereof, a latitude of modification, various changes and substitutions are intended in the foregoing disclosure, and it will be appreciated that in some instances some features of the invention will be employed without a corresponding use of other features without departing from the scope of the invention as set forth. Therefore, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope and spirit of the present invention. It is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments and equivalents falling within the scope of the claims.

[**0012**] The entire contents of Appendix A, "Topaz™ Growth Chip, User Guide", Fluidigm Corporation, So. San Francisco, Calif., 94080, which is s part of U.S. Provisional Application No. 60/525,245 (the application to which this application claims priority), filed Nov. 26, 2003, is expressly incorporated herein by reference in its entirety for all purposes. Appendix A is thus is to be construed as part of the present specification for all purposes.

What is claimed is:

1. A carrier for holding a microfluidic device comprising:

a housing, said housing defining a chamber therein and having a receiving portion for receiving said microfluidic device;

a connection block for retaining said microfluidic device, wherein said connection block is attachable to said microfluidic device through one or more prongs, and said microfluidic device, when retained by said connection block, is insertable into said receiving portion of said housing.

2. The carrier of claim 1 wherein said one or more prongs is two or more prongs.

3. The carrier of claim 1 wherein at least one of said one or more prongs is a tube.

4. The carrier of claim 1 wherein said receiver has at least one slot for guiding and retaining said microfluidic device when inserted into said receiving portion.

5. The carrier of claim 1 wherein said receiver further comprises one or more pipette supports for guiding a pipette tip into said microfluidic device when inserted into said receiving portion.

6. The carrier of claim 1 further comprising an accumulator for providing fluid under pressure to said microfluidic device when inserted into said receiving portion.

7. The carrier of claim 6 wherein said accumulator further comprises a check valve.

8. The carrier of claim 1 wherein said housing comprises a housing base and a housing cover.

9. The carrier of claim 8 further comprising an accumulator attached to said housing.

10. The carrier of claim 8 wherein said housing cover and said housing base are sealed together by a gasket.

11. The carrier of claim 1 further comprising a humidity control material therein.

12. The carrier of claim 11 wherein said humidity control material is selected from the group consisting of a sponge, a gel matrix, a desiccant, and a woven material.

13. The carrier of claim 1 wherein said housing is made from a polymer.

14. The carrier of claim 13 wherein said polymer is either polycarbonate or acrylic or polystyrene.

15. The carrier of claim 6 wherein said accumulator is in fluid communication with said connection block through one or more accumulator-connection block tubes.

16. The carrier of claim 15 wherein said accumulator-connection block tubes is flexible.

17. The carrier of claim 1 wherein a first tube of said one or more tubes is in communication with said microfluidic device for controlling one or more first valves.

18. The carrier of claim 1 wherein a second tube of said one or more tubes is in communication with said microfluidic device for controlling one or more second valves.

19. The carrier of claim 17 wherein said first valves are interface valves.

20. The carrier of claim 18 wherein said second valves are containment valves.

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