MICROFLUIDIC DEVICES AND USES THEREOF

[0001] CROSS-REFERENCE

[0002] This application claims the benefit of the filing date of U.S. Provisional Patent Application 61/227,409 filed on Jul. 21, 2009.

STATEMENT OF JOINT DEVELOPMENT

[0003] This invention was created pursuant to a joint research agreement between IntegenX, Inc. and Samsung Electronic Co., Ltd.

BACKGROUND OF THE INVENTION

[0004] Microfluidic platforms have been developed to perform molecular biology protocols on chips. Typically, microfluidic platforms have utilized conventional lithography with hard materials and have relied on electrokinetic or pressure-based fluid transport, both of which are difficult to control and provide extremely limited on-chip valving and pumping options. Other platforms have utilized soft-lithography methods that have been plagued by problems related to absorption, evaporation, and chemical compatibility.

[0005] It is therefore desirable to provide improved methods and apparatus for implementing microfluidic control mechanisms such as valves, pumps, routers, reactors, etc. to allow effective integration of sample introduction, preparation processing, and analysis capabilities in a microfluidic device.

SUMMARY OF THE INVENTION

[0006] The invention provides for a device comprising a cartridge; a microfluidic chip having one or more microfluidic diaphragm valves, fluidically interfaced with the cartridge; and a base comprising a support structure, one or more temperature controlling devices that are in thermal contact with the cartridge, and pneumatic lines for pneumatically actuating the microfluidic chip.

[0007] In some embodiments, the base further comprises a pneumatic floater that is positioned within the support structure. In other embodiments, the pneumatic floater is supported by springs that force the pneumatic floater toward the microfluidic chip. The pneumatic floater may supported by springs that allow for an air-tight seals between the pneumatic floater and the microfluidic chip. In some embodiments, the support structure is rigid. The base may further comprise a pneumatic insert that is fluidically connected with the cartridge. In some instances, the cartridge comprises a thermistor. The cartridge can be formed from cyclic olefin copolymer. The cartridge may be injection molded. In some embodiments, the support structure is a heat sink.

[0008] In other embodiments, the device further comprises a pneumatic manifold mounted on the base, wherein the pneumatic manifold comprises vias or channels that are in pneumatic communication with the pneumatic lines and with pneumatic ports on the microfluidic chip to deliver pressure or vacuum to the chip to actuate the diaphragm valves, and wherein the pneumatic manifold is mounted on the support in a configuration biased to engage the chip and to allow the temperature controlling devices also to be in thermal contact with the cartridge.

[0009] The invention provides for a device comprising a microfluidic chip having one or more pneumatically actuated valves and one or more chambers; and a cartridge, wherein the cartridge comprises one or more reservoirs that are fluidically connected with the chambers and the reservoirs are sized such that a material can be directly pipetted into the chamber.

INCORPORATION BY REFERENCE

[0010] All publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The novel features of the invention are set forth with particularity in the appended claims. A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the invention are utilized, and the accompanying drawings of which:

[0012] FIG. **1** depicts a device with a cartridge, microfluidic chip, and a magnet.

[0013] FIG. **2** depicts a fluidic manifold encased by an aluminum bezel.

[0014] FIG. **3** shows a photograph of four thermoelectric coolers and a heat distributing device mounted onto a fluidic manifold.

[0015] FIG. **4**A shows a thermoelectric cooler coupled to a heat sink, a fan, and a manifold.

[0016] FIG. **4**B shows four thermoelectric coolers coupled to an electrical power supply.

[0017] FIG. **5** shows an exploded view of a reservoir, chip, pneumatic floater, pneumatic inserts, thermoelectric coolers, and an aluminum manifold.

[0018] FIG. **6** shows an assembled view of the system shown in FIG. **5**.

[0019] FIG. **7** shows a top view and a bottom view of a fluidic manifold.

[0020] FIG. **8** shows a photograph of a fluidic manifold mounted to a base.

[0021] FIG. **9** shows a top view of a fluidic manifold.

[0022] FIG. **10** shows a side view of a base with thermoelectric coolers and a pneumatic floater.

[0023] FIG. **11** shows an exploded view of a fluidic manifold formed from injection molded cyclic olefin copolymer.

[0024] FIG. **12** shows multiple views of a fluidic manifold formed from injection molded cyclic olefin copolymer.

[0025] FIG. **13** shows an exploded view of a TEC stack, a fluidic manifold, a microfluidic chip and a pneumatic manifold.

[0026] FIG. **14** depicts a microfluidic chip with a fluidics layer, an elastomeric layer, and a pneumatics layer.

[0027] FIG. **15** depicts a microscale on-chip valve (MOVe).

[0028] FIG. **16** depicts a fluidics layer made of two layers of material.

[0029] FIG. **17** depicts a fluidics layer made of a single layer of material.

[0030] FIG. **18** depicts fluidics and pneumatic layers of a microfluidic chip with a reagent and bead rail.