[0006] According to a first aspect of the present disclosure, there is provided a microfluidic device for processing a biological sample, including: a substrate, including: a single inlet port configured to direct a solution including said biological sample, a channel connected to said single inlet port, wherein said channel is configured to receive said solution including said biological sample via said single inlet port, a plurality of chambers in fluid communication with said channel, wherein each chamber of said plurality of chambers comprises a single chamber port and is dead-ended, and wherein said single chamber port of said each chamber is in fluid communication with said channel, wherein the single inlet port, the channel and the plurality of chambers collectively define a fluid flow path, wherein said each chamber is configured to (1) receive, via said chamber port, at least a portion of said solution from said channel and (ii) retain said at least said portion of said solution during said processing, and a thermoplastic film over said channel and said plurality of chambers, wherein said thermoplastic film is made from a material that is configured to prevent gas fouling of said microfluidic device via pressurized off-gassing of gas from said channel and said plurality of chambers whereby pressure is applied at said single inlet port.

[0007] In some embodiments, the microfluidic device further comprises a plurality of chambers in fluid communication with the channel, wherein the plurality of chambers comprises the chamber. In some embodiments, the channel comprises a first end and a second end, and wherein the first end and the second end are connected to a single inlet port. In some embodiments, the fluid flow path is circular. In some embodiments, the channel comprises a first end and a second end, and wherein the first end is connected to the inlet port and the second end is connected to a outlet port.

[0008] In some embodiments, the chamber is configured to permit pressurized off-gassing. In some embodiments, the chamber comprises a film or membrane that permits the pressurized off-gassing. In some embodiments, the film or membrane is polymer film or membrane. In some embodiments, the polymer film or membrane does not comprise an elastomer. In some embodiments, the film or membrane has a thickness of less than about 100 micrometers (μm). In some embodiments, the thickness is less than about 50 μm. In some embodiments, the film or membrane is substantially impermeable to liquids.

[0009] In some embodiments, the fluid flow path or the chamber does not include a valve. In some embodiments, a volume of the chamber is less than or equal to about 250 picoliters. In some embodiments, a volume of the chamber is less than or equal to about 500 picoliters. In some embodiments, the chamber has a cross-sectional dimension of less than or equal to about 250 μm.

In some embodiments, the chamber has a depth of less than or equal to about 250 μm. In some embodiments, the microfluidic device further comprises a siphon aperture disposed between the channel and the chamber, wherein the siphon aperture is configured to provide fluid communication between the channel and the chamber.

[0010]

[0011] In some embodiments, the device comprises a plurality of chambers in fluid communication with the channel, and wherein the plurality of chambers comprises the chamber. In some embodiments, the method further comprises applying a single pressure differential to the inlet port to direct solution from the inlet port to the channel and from the channel to the chamber. In some embodiments, the single pressure differential permits pressurized off-gassing of gas in the chamber.

[0012] In some embodiments, the method further comprises applying a first pressure differential to the inlet port to direct the solution from the inlet port to the channel. In some embodiments, the method further comprises applying a second pressure differential to the inlet port to direct the solution from the channel to the chamber. In some embodiments, the second pressure differential is greater than the first pressure differential. In some embodiments, the second pressure differential permits pressurized off-gassing of gas in the chamber. In some embodiments, the chamber comprises a film or membrane, and wherein the film or membrane permits pressurized off-gassing of the gas in the chamber.

[0013] In some embodiments, a volume of the solution is less than or equal to a volume of the chamber. In some embodiments, the device partitions the solution comprising the biological sample into the chamber such that no residual solution remains in the channel. In some embodiments, the method further comprises providing an immiscible fluid to the inlet port and directing the immiscible fluid to the channel. In some embodiments, a volume of the immiscible fluid is greater than a volume of the channel. In some embodiments, the biological sample is a nucleic acid molecule. In some embodiments, the method further comprises amplifying the nucleic acid molecule by thermal cycling the chamber. In some embodiments, the method further comprises controlling a temperature of the channel or the chamber. In some embodiments, the method further comprises detecting one or more components of the biological sample or a reaction with the one or more components of the biological sample in the chamber. In some embodiments, detecting the one or more components of the biological sample or the reaction comprises imaging the chamber.

[0014] According to a second aspect of the present disclosure, there is provided a system for processing a biological sample, including: the above microfluidic device; a holder configured to receive or retain said device during said processing; and a fluid flow module configured to fluidically couple to said inlet port and supply a pressure differential to subject (i) said solution to flow from said inlet port to said channel and (ii) said at least said portion of said solution to flow from said channel to said chamber, said at least said portion of said solution in said chamber being isolated by removing said solution from said channel.

[0015] In some embodiments, the device comprises a plurality of chambers in fluid communication with the channel, and wherein the plurality of chambers comprises the chamber. In some embodiments, the chamber of the device is configured to permit pressurized off-gassing of a gas in the chamber when the fluid flow module applies the pressure differential to the inlet port. In some embodiments, the chamber comprises a film or membrane that is configured to permit the pressurized off-gassing.

[0016] In some embodiments, the system further comprises one or more computer processors operatively coupled to the fluid flow module, wherein the one or more computer processors are individually or collectively programmed to direct the fluid flow module to supply the pressure differential when the fluid flow module is fluidically coupled to the inlet port, to thereby subject the solution to flow from the inlet port to the channel and direct the at least the portion of the solution from the channel to the chamber. In some embodiments, the system further comprises a thermal module in thermal communication with the chamber, wherein the thermal module is configured to control a temperature of the chamber during the processing. In some embodiments, the system further comprises a detection module in communication with the chamber, wherein the detection module is configured to detect a content of the chamber during the processing. In some embodiments, the detection module is an optical module in optical communication with the chamber. In some embodiments, the optical module is configured to image the chamber.

[0017] According to a third aspect of the present disclosure, there is provided a system for processing a biological sample, including: the above microfluidic device; a holder configured to receive or retain said device during said processing; and one or more computer processors configured to be operatively coupled to said device when said device is retained by said holder, wherein said one or more computer processors are individually or collectively programmed to (i) direct a solution comprising said biological sample from said inlet port to said channel; and (ii) direct a portion of said solution from said channel to said chamber, which chamber retains said

portion of said solution during said processing of the biological sample, said portion of said solution in said chamber being isolated by removing said solution from said channel.

[0018] In some embodiments, the system further comprises a fluid flow module operatively coupled to said one or more computer processors, wherein said fluid flow module is configured to be operatively coupled to said device when said device is retained by said holder, and wherein said one or more computer processors are programmed to direct said fluid flow module to direct said solution from said inlet port to said channel.

[0019] In some embodiments, the system further comprises a thermal module configured to be in thermal communication with said chamber when said device is retained by said holder, wherein said thermal module is configured to control a temperature of said chamber during said processing.

[0020] In some embodiments, the system further comprises a detection module configured to be in communication with said chamber when said device is retained by said holder, wherein said detection module is configured to detect a content of said chamber during said processing. In some embodiments, the detection module is an optical module in optical communication. In some embodiments, the optical module is configured to image said chamber.

[0021] Additional aspects and advantages of the present disclosure will become readily apparent to those skilled in this art from the following detailed description, wherein only illustrative embodiments of the present disclosure are shown and described. As will be realized, the present disclosure is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the disclosure. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not as restrictive.

INCORPORATION BY REFERENCE

[0022] 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. To the extent publications and patents or patent applications incorporated by reference contradict the disclosure contained in the specification, the specification is intended to supersede and/or take precedence over any such contradictory material.

CLAIMS:

1. A microfluidic device for processing a biological sample, comprising:

a substrate, including:

a single inlet port configured to direct a solution including said biological sample,

a channel connected to said single inlet port, wherein said channel is configured to receive said solution including said biological sample via said single inlet port,

a plurality of chambers in fluid communication with said channel, wherein each chamber of said plurality of chambers comprises a single chamber port and is dead-ended, and wherein said single chamber port of said each chamber is in fluid communication with said channel,

wherein the single inlet port, the channel and the plurality of chambers collectively define a fluid flow path,

wherein said each chamber is configured to (1) receive, via said chamber port, at least a portion of said solution from said channel and (ii) retain said at least said portion of said solution during said processing, and

a thermoplastic film over said channel and said plurality of chambers, wherein said thermoplastic film is made from a material that is configured to prevent gas fouling of said microfluidic device via pressurized off-gassing of gas from said channel and said plurality of chambers whereby pressure is applied at said single inlet port.

2. The microfluidic device of claim 1, wherein said chamber is configured to permit pressurized off-gassing.

3. The microfluidic device of claim 1, wherein said film is a polymer film.

4. The microfluidic device of claim 3, wherein said polymer film other than comprises an elastomer.

5. The microfluidic device of claim 1, wherein said film has a thickness of less than 100 micrometers (μm).

6. The microfluidic device of claim 5, wherein said thickness is less than 50 μm.

7. The microfluidic device of claim 1, wherein said film is substantially impermeable to liquids.

8. The microfluidic device of claim 1, wherein a volume of said chamber is less than or equal to 500 picoliters.

9. The microfluidic device of claim 1, wherein a volume of said chamber is less than or equal to 250 picoliters.

10. The microfluidic device of claim 1, wherein said chamber has a cross-sectional dimension of less than or equal to 250 μm.

11. The microfluidic device of claim 1, wherein said chamber has a depth of less than or equal to 250 μm.

12. The microfluidic device of claim 1, further comprising a siphon aperture disposed between said channel and said chamber, wherein said siphon aperture is configured to provide fluid communication between said channel and said chamber.

13. A system for processing a biological sample, comprising:

the microfluidic device according to claim 1;

a holder configured to receive or retain said device during said processing; and

a fluid flow module configured to fluidically couple to said inlet port and supply a pressure differential to subject (i) said solution to flow from said inlet port to said channel and (ii) said at least said portion of said solution to flow from said channel to said chamber, said at least said portion of said solution in said chamber being isolated by removing said solution from said channel.

14. The system of claim 13, wherein said chamber of said device is configured to permit pressurized off-gassing of a gas in said chamber when said fluid flow module applies said pressure differential to said inlet port.

15. The system of claim 13, further comprising one or more computer processors operatively coupled to said fluid flow module, wherein said one or more computer

processors are individually or collectively programmed to direct said fluid flow module to supply said pressure differential when said fluid flow module is fluidically coupled to said inlet port, to thereby subject said solution to flow from said inlet port to said channel and direct said portion of said solution from said channel to said chamber.

16. The system of claim 13, further comprising a thermal module in thermal communication with said chamber, wherein said thermal module is configured to control a temperature of said chamber during said processing.

17. The system of claim 13, further comprising a detection module in communication with said chamber, wherein said detection module is configured to detect a content of said chamber during said processing.

18. The system of claim 17, wherein said detection module is an optical module in optical communication with said chamber.

19. The system of claim 18, wherein said optical module is configured to image said chamber.

20. A system for processing a biological sample, comprising:

the microfluidic device according to claim 1;

a holder configured to receive or retain said device during said processing; and

one or more computer processors configured to be operatively coupled to said device when said device is retained by said holder, wherein said one or more computer processors are individually or collectively programmed to (i) direct a solution comprising said biological sample from said inlet port to said channel; and (ii) direct a portion of said solution from said channel to said chamber, which chamber retains said portion of said solution during said processing of the biological sample, said portion of said solution in said chamber being isolated by removing said solution from said channel.

21. The system of claim 20, further comprising a fluid flow module operatively coupled to said one or more computer processors, wherein said fluid flow module is configured to be operatively coupled to said device when said device is retained by said

holder, and wherein said one or more computer processors are programmed to direct said fluid flow module to direct said solution from said inlet port to said channel.

22. The system of claim 20, further comprising a thermal module configured to be in thermal communication with said chamber when said device is retained by said holder, wherein said thermal module is configured to control a temperature of said chamber during said processing.

23. The system of claim 20, further comprising a detection module configured to be in communication with said chamber when said device is retained by said holder, wherein said detection module is configured to detect a content of said chamber during said processing.

24. The system of claim 23, wherein said detection module is an optical module in optical communication.

25. The system of claim 24, wherein said optical module is configured to image said chamber.