WHAT IS CLAIMED IS:

1. A microfluidic device comprising:

an input source characterized by a source pressure;

an input channel in fluid communication with the input source;

an output channel;

a valve having an open state and a closed state, wherein the valve is disposed between the input channel and the output channel and is characterized by a static pressure; and

a control channel coupled to the valve and characterized by a control pressure, wherein, in the closed state, the control pressure is greater than atmospheric pressure.

2. The microfluidic device of claim 1 wherein the valve comprises a normally closed valve.

3. The microfluidic device of claim 1 wherein the open state of the valve is associated with a source pressure greater than or equal to the sum of the control pressure and the static pressure.

4. The microfluidic device of claim 1 wherein the input source comprises a pressurized fluid source.

5. The microfluidic device of claim 1 wherein the output channel is in fluid communication with atmospheric pressure.

6. The microfluidic device of claim 1 wherein the valve comprises a contact area between opposing portion of a flow channel coupling the input channel to the output channel.

7. The microfluidic device of claim 6 wherein the control channel has a width and length measured in a plane including the flow channel greater than the contact area.

8. The microfluidic device of claim 1 wherein the microfluidic device comprises a logic gate.

9. The microfluidic device of claim 1 wherein the microfluidic device comprises a latch, a flip-flop, an oscillator, a check valve, a releasable check valve, a pump, a memory element, a flow regulator, a shift register, or a fluidic CPU.

10. The microfluidic device of claim 1 wherein the output channel is in fluid communication with the input source and the input channel is in fluid isolation from the input source.

11. The microfluidic device of claim 1 wherein the closed state of the valve is associated with the source pressure less than the sum of the control pressure and the static pressure.

12. A method of fabricating a microfluidic device, the method comprising:

forming a control layer including a control channel and a control layer membrane;

forming a flow layer coupled to the control layer, wherein the flow layer includes a flow channel and a flow layer membrane;

forming a fill layer coupled to the flow layer, wherein the fill layer includes a fill channel and a fill layer membrane;

injecting a fill material into the fill channel;

deflecting a portion of the flow layer membrane to make contact with a portion of the control layer membrane; and

curing the fill material.

13. The method of claim 12 wherein the control channel comprises a chamber underlying the flow channel.

14. The method of claim 12 wherein the control layer membrane and the fill layer membrane comprise PDMS.

15. The method of claim 12 wherein the fill material comprises an acrylate monomer.

16. The method of claim 12 wherein the contact between the portion of the flow layer membrane and the portion of the control layer membrane impedes flow through the flow channel.

17. The method of claim 12 wherein curing the fill material comprises exposing the fill material to at least UV radiation, visible radiation, or thermal energy.

18. The method of claim 12 wherein the microfluidic device comprises a normally closed valve.

19. A microfluidic device comprising:

a substrate;

a control layer coupled to the substrate, wherein the control layer includes a control channel and a control layer membrane;

a flow layer coupled to the control layer, wherein the flow layer includes a flow channel and a flow layer membrane;

a fill layer coupled to the flow layer, wherein the fill layer includes a fill channel and a fill layer membrane, wherein a portion of the fill layer extends toward the control layer and wherein a portion of the flow layer membrane is in contact with a portion of the control layer membrane.

20. The microfluidic device of claim 19 wherein the contact between the portion of the flow layer membrane and the portion of the control layer membrane defines a contact area.

21. The microfluidic device of claim 20 wherein the contact area impedes flow through the flow channel.

22. The microfluidic device of claim 20 wherein the control channel has a width and length measured in the plane of the substrate greater than the contact area.

23. The microfluidic device of claim 19 wherein the substrate comprises at least one of a polymer, glass, or silicon.

24. The microfluidic device of claim 19 wherein the control layer membrane and the fill layer membrane comprise PDMS.

25. The microfluidic device of claim 19 wherein the fill layer membrane comprises an elastic or plastic polymer.

26. A microfluidic system comprising:

a substrate;

a set of input ports coupled to the substrate;

a set of output ports coupled to the substrate;

a microfluidic processing system coupled to the substrate and including a plurality of processing sites, wherein the microfluidic processing system is coupled to the set of input ports and the set of output ports;

one or more microfluidic logic devices coupled to the substrate and operable to control at least a portion of the microfluidic processing system.

27. The microfluidic system of claim 26 wherein the plurality of processing sites are disposed in an array configuration.

28. The microfluidic system of claim 26 wherein the microfluidic processing system comprises a plurality of arrays of processing sites.

29. The microfluidic system of claim 26 wherein the one or more microfluidic logic devices comprise binary logic gates.

30. The microfluidic system of claim 29 wherein the binary logic gates comprise at least one of buffer, NOT, NOR, or NAND gates.

31. The microfluidic system of claim 26 wherein the plurality of processing sites comprise reaction chambers.

32. The microfluidic system of claim 26 further comprising a processor and memory.

33. A microfluidic device comprising:

an input source characterized by a source pressure;

an input channel in fluid communication with the input source;

an output channel;

a normally closed valve having a closed state and an open state, wherein the normally closed valve is disposed between the input channel and the output channel; and

one or more release chambers coupled to a pressure source, wherein activation of the pressure source deforms the one or more release chambers, placing the normally closed valve in the open state.

34. The microfluidic device of claim 33 wherein the one or more release chambers comprise a set of release chambers, each of the set of release chambers being disposed on opposing sides of the normally closed valve.

35. The microfluidic device of claim 33 wherein activation of the pressure source deforms the one or more release chambers by expansion of the one or more release chambers.

36. The microfluidic device of claim 33 further comprising a second pressure source coupled to the normally closed valve and operable to modify a transition pressure between the closed state and the open state.

37. A control system for a microfluidic device, the control system comprising:

a first microfluidic valve array;

a second microfluidic valve array;

a first I/O port in fluid communication with a first control line and a second control line;

a second I/O port in fluid communication with a third control line and a fourth control line;

a first valve having an input coupled to the first control line, an output coupled to the first microfluidic valve array, and a control;

a second valve having an input coupled to the second control line, an output, and a control coupled to the third control line;

a third valve having an input coupled to the third control line, an output coupled to the second microfluidic valve array, and a control; and

a fourth valve having an input coupled to the fourth control line, an output, and a control coupled to the first control line, wherein:

the control of the first valve is coupled to the output of the fourth valve; and

the control of the third valve is coupled to the output of the second valve.

38. The control system of claim 37 wherein the first microfluidic array comprises an interface control array and the second microfluidic array comprises a containment control array.

39. The control system of claim 37 wherein the first valve, the second valve, the third valve, and the fourth valve comprise releasable check valves.

40. The control system of claim 39 wherein the releasable check valves include a normally closed valve.

41. The control system of claim 37 wherein the first I/O port is coupled to a pressure source providing low, intermediate, and high pressures.

42. The control system of claim 41 wherein the second I/O port is coupled to the pressure source providing low, intermediate, and high pressures.

**Claims:**

1. A method of fabricating a microfluidic device, the method comprising:

forming a control layer including a control channel and a control layer membrane;

forming a flow layer coupled to the control layer, wherein the flow layer includes a flow channel and a flow layer membrane;

forming a fill layer coupled to the flow layer, wherein the fill layer includes a fill channel and a fill layer membrane;

injecting a fill material into the fill channel;

deflecting a portion of the flow layer membrane to make contact with a portion of the control layer membrane; and

curing the fill material.

2. The method of claim 1 wherein the control channel comprises a chamber underlying the flow channel.

3. The method of claim 1 wherein the control layer membrane and the fill layer membrane comprise PDMS.

4. The method of claim 1 wherein the fill material comprises an acrylate monomer.

5. The method of claim 1 wherein the contact between the portion of the flow layer membrane and the portion of the control layer membrane impedes flow through the flow channel.

6. The method of claim 1 wherein curing the fill material comprises exposing the fill material to at least UV radiation, visible radiation, or thermal energy.

7. The method of claim 1 wherein the microfluidic device comprises a normally closed valve.

8. A microfluidic device comprising:

a substrate;

a control layer coupled to the substrate, wherein the control layer includes a control channel and a control layer membrane;

a flow layer coupled to the control layer, wherein the flow layer includes a flow channel and a flow layer membrane;

a fill layer coupled to the flow layer, wherein the fill layer includes a fill channel and a fill layer membrane, wherein a solid fill material present in the fill layer deflects the flow layer membrane toward the control layer and wherein a portion of the flow layer membrane is in contact with a portion of the control layer membrane.

9. The microfluidic device of claim 8 wherein the contact between the portion of the flow layer membrane and the portion of the control layer membrane defines a contact area.

10. The microfluidic device of claim 9 wherein the control channel comprises a chamber underlying the flow channel.

11. The microfluidic device of claim 9 wherein the control channel has a width and length measured in the plane of the substrate greater than the contact area.

12. The microfluidic device of claim 8 wherein the substrate comprises at least one of a polymer, glass, or silicon.

13. The microfluidic device of claim 8 wherein the control layer membrane and the fill layer membrane comprise PDMS.

14. The microfluidic device of claim 8 wherein the fill layer membrane comprises an elastic or plastic polymer.