CLAIMS

1. A method comprising:

(a) forming a laminated microfluidic structure having a first major surface and a second major surface offset from the first major surface by a first distance along an axis perpendicular to the first major surface, wherein the laminated microfluidic structure includes:

at least two layers, wherein each layer is made of a polymeric material,

at least one channel that extends in one or more directions parallel to the first major surface and is located within the laminated microfluidic structure, and

one or more sipper ports that fluidically connect one or more openings in the first major surface with the at least one channel;

(b) placing the laminated microfluidic structure in a thermoforming apparatus; and

(c) thermoforming a first region of the laminated microfluidic structure around the one or more sipper ports to cause the first region to distend away from a reference plane defined by undistended portions of the first major surface to form a well with the one or more sipper ports located within the distended first region.

2. The method of claim 1, wherein the laminated microfluidic structure further includes one or more vent ports in the first region fluidically connected with one or more vent channels that lead outside of the first region.

3. The method of either claim 1 or claim 2, wherein (c) comprises:

heating at least the first region to a first temperature above a glass transition temperature of the polymeric material or materials of the at least two layers;

positioning the at least two layers between (i) a first mold having a protrusion in a location that aligns with the first region when viewed along an axis perpendicular to the reference plane and (ii) a second mold having a recess in a location that aligns with the first region when viewed along an axis perpendicular to the reference plane; and

causing, while the first region is heated to the first temperature, one or both of the first mold and the second mold to move along a first axis to deform the at least two layers between the first mold and the second mold and cause the first region to distend into the recess.

4. The method of claim 3, wherein at least one of the protrusion and the recess includes a relief groove on a surface thereof and positioned such that the relief groove at least partially

overlaps with the at least one channel during (c) when viewed along an axis perpendicular to the reference plane.

5. The method of either claim 1 or claim 2, wherein (c) comprises:

placing the second major surface against a mold with a recess in a location that aligns with the first region when viewed along an axis perpendicular to the reference plane;

heating at least the first region to a first temperature above a glass transition temperature of the polymeric material or materials of the at least two layers; and

applying a pressure differential to the laminated microfluidic structure while the second major surface is placed against the mold and the recess is in the location that aligns with the first region to cause the first region to thermoplastically distend into the recess.

6. The method of claim 5, wherein the recess includes a relief groove on a surface thereof and positioned such that the relief groove at least partially overlaps with the at least one channel during (c) when viewed along an axis perpendicular to the reference plane.

7. The method of either claim 1 or claim 2, wherein (c) comprises:

placing the first major surface against a mold with a protrusion in a location that aligns with the first region;

heating at least the first region to a first temperature above a glass transition temperature of the polymeric material or materials of the at least two layers; and

applying a pressure differential to the laminated microfluidic structure while the first major surface is placed against the mold and the protrusion is in the location that aligns with the first region to cause the first region to thermoplastically distend over the protrusion.

8. The method of claim 7, wherein the protrusion includes a relief groove on a surface thereof and positioned such that the relief groove at least partially overlaps with the at least one channel during (c) when viewed along an axis perpendicular to the reference plane.

9. The method of either claim 1 or claim 2, wherein (c) comprises:

heating at least the first region to a first temperature above a glass transition temperature of the polymeric material or materials of the at least two layers; and

causing, while the first region is heated to the first temperature, a first pressure field to be applied to the first major surface over the first region and a second pressure field to be applied to the second major surface over the first region, wherein:

the first pressure field is, on average, greater than the second pressure field and results in a pressure field differential between the first major surface and the second major surface, and

the pressure field differential causes the first region to distend away from the first major surface.

10. The method of any one of claims 1 through 9, further comprising:

dispensing a quantity of reagent into the distended first region, and

bonding or adhering a seal over the distended first region after the quantity of reagent is dispensed into the distended first region.

11. The method of any one of claims 1 through 10, further comprising:

(d) positioning, after (c), the laminated microfluidic structure within a mold cavity of an injection molding machine mold; and

(e) injecting molten polymeric material into the mold cavity to cause at least some of the molten polymeric material to flow against one or more portions of the laminated microfluidic structure positioned therein.

12. The method of claim 11, wherein:

the laminated microfluidic structure includes one or more ports on one or both of the first major surface and the second major surface, and

the injection molding machine mold includes one or more protrusions that contact the laminated microfluidic structure around each port of all or a subset of the one or more ports during (e), thereby preventing the molten polymeric material from flowing into the ports in the all or subset of one or more ports during (e).

13. The method of any one of claims 1 through 10, further comprising:

obtaining a housing made of a polymeric material;

heating the laminated microfluidic structure to a temperature above a glass transition temperature of the polymeric material or materials of the at least two layers;

pressing one or more portions of the laminated microfluidic structure against the housing to bond the laminated microfluidic structure to the housing.

14. A method comprising:

(a) obtaining a first microfluidic layer having a first major surface and a second major surface on an opposite side of the first microfluidic layer from the first major surface, wherein:

the first major surface has a concave shape in a first region of the first microfluidic layer and the second major surface has a corresponding convex shape in the first region of the first microfluidic layer, and

the first microfluidic layer includes one or more sipper ports located within the first region and passing through the first microfluidic layer;

(b) obtaining a second microfluidic layer having a third major surface and a fourth major surface on an opposite side of the second microfluidic layer from the third major surface, wherein:

the third major surface has a concave shape in a second region of the second microfluidic layer and the fourth major surface has a corresponding convex shape in the second region of the second microfluidic layer,

the second major surface and the third major surface have matching profiles, and

one or both of the second major surface and the third major surface includes one or more channels;

(c) stacking the first microfluidic layer and the second microfluidic layer such that the first region is nested in the second region and the one or more channels is in fluidic communication with the one or more sipper ports in between the first major surface and the fourth major surface; and

(d) bonding at least a portion of the second major surface of the first microfluidic layer to at least a portion of the third major surface of the second microfluidic layer.

15. The method of claim 14, further comprising providing at least one of (i) the concave shape of the first major surface and the convex shape of the second major surface and (ii) the concave shape of the third major surface and the convex shape of the fourth major surface by injection molding at least one of the first microfluidic layer and the second microfluidic layer, respectively.

16. The method of claim 14, further comprising providing at least one of (i) the concave shape of the first major surface and the convex shape of the second major surface and (ii) the concave shape

of the third major surface and the convex shape of the fourth major surface by thermoforming at least one of the first microfluidic layer and the second microfluidic layer, respectively.

17. The method of claim 16, wherein:

the second major surface includes at least one of the one or more channels,

the first microfluidic layer is thermoformed using a mold having a recess with a recessed surface positioned so as to contact the second major surface within the first region, and

the recess includes a debossing feature that is proud of the recessed surface and that forms the channel in the second major surface during the thermoforming of the first microfluidic layer.

18. The method of claim 16, wherein:

the third major surface includes at least one of the one or more channels,

the second microfluidic layer is thermoformed using a mold having a protrusion surface positioned so as to contact the third major surface within the second region, and

the protrusion includes a debossing feature that is proud of the protrusion surface and that forms the channel in the third major surface during the thermoforming of the second microfluidic layer.

19. An apparatus comprising:

a laminated microfluidic structure having a first major surface and a second major surface offset from the first major surface, wherein the laminated microfluidic structure has a first distended region that includes a concave portion of the first major surface and a corresponding convex portion of the second major surface;

a sipper port located on the first major surface within the first distended region; and

a channel that fluidically connects the sipper port to a location outside of the first distended region and that is interposed between the first major surface and the second major surface.

20. The apparatus of claim 19, further comprising:

a first quantity of reagent located within the concave portion of the first major surface; and

a seal that is sealed to the first major surface around the periphery of the first distended region.

21. The apparatus of either claim 19 or claim 20, further comprising:

a vent port located on the first major surface within the first distended region; and

a vent channel that fluidically connects the vent port to a location outside of the first distended region and that is interposed between the first major surface and the second major surface.

22. The apparatus of either claim 19 through 21, wherein:

the laminated microfluidic structure is a laminated microfluidic structure including at least a first layer and a second layer,

the first layer includes a third major surface,

the second layer includes a fourth major surface,

the third major surface is bonded to the fourth major surface, and

the channel is located in one or both of the third major surface and the fourth major surface.

23. The apparatus of any one of claims 19 through 22, wherein:

the first distended region is surrounded by a first non-distended region of the laminated microfluidic structure,

the first non-distended region of the laminated microfluidic structure defines a first reference plane, and

the sipper port is positioned in a location that is spaced away from the first reference plane along an axis perpendicular to the first reference plane by a distance of between 90% and 100% of the distance between the first reference plane and a portion of the first major surface within the first distended region that is furthest from the first reference plane.

24. The apparatus of any one of claims 19 through 23, further comprising one or more additional distended regions, each additional distended region having a corresponding additional sipper port and a corresponding additional channel that fluidically connects that additional sipper port to a location outside of the corresponding additional distended region and that is interposed between the first major surface and the second major surface.

25. The apparatus of any one of claims 19 through 24, further comprising:

a co-molded housing that is fused to the laminated microfluidic structure in a co-molding process.

26. The apparatus of any one of claims 19 through 24, further comprising:

a co-molded housing, wherein the laminated microfluidic structure is located within the co-molded housing in a position that prevents the laminated microfluidic structure from being removed from the co-molded housing without deforming the co-molded housing or the laminated microfluidic structure.

27. The apparatus of any one of claims 19 through 24, further comprising:

a molded housing made from a polymeric material that is fused to the laminated microfluidic structure in a thermoforming process and therefore is joined to the molded housing by a region of polymeric material of the molded housing that is molecularly entangled with polymeric material of the laminated microfluidic structure.

28. The apparatus of either of claims 25 or 26, wherein the laminated microfluidic structure includes one or more rigid polymeric layers and an elastomeric membrane that is in contact with one of the rigid polymeric layers on one side and that contacts the co-molded housing on an opposing side.

29. The apparatus of claim 28, wherein the rigid polymeric layer that contacts the elastomeric membrane includes a diaphragm recess and the co-molded housing extends around the diaphragm recess but does not overlap with the diaphragm recess when viewed along an axis perpendicular to the first major surface within the first distended region.

30. An apparatus comprising:

a laminated microfluidic structure having a first major surface and a second major surface offset from the first major surface, the laminated microfluidic structure comprises one or more rigid polymeric layers with a diaphragm recess and an elastomeric membrane, wherein the elastomeric membrane and the diaphragm recess work together to control a flow of a fluid therein; wherein the laminated microfluidic structure includes one or more channels and vias interposed between the first major surface and the second major surface; and

a co-molded housing that is fused to the laminated microfluidic structure in a co-molding process.

31. The apparatus of claim 30, wherein the laminated microfluidic structure is located within the co-molded housing in a position that prevents the laminated microfluidic structure from being

removed from the co-molded housing without deforming the co-molded housing or the laminated microfluidic structure.

32. The apparatus of either of claims 30 or 31, the elastomeric membrane is in contact with one of the rigid polymeric layers on one side and that contacts the co-molded housing on an opposing side.

33. The apparatus of claim 32, wherein the rigid polymeric layer contacts the elastomeric membrane and the co-molded housing extends around the diaphragm recess but does not overlap with the diaphragm recess when viewed along an axis perpendicular to the first major surface within a first distended region.