CLAIMS

1. A fluid delivery system comprising:

a back plane;

a first substrate block mounted to an upper surface of the back plane, the first substrate block comprising:

a first upper surface;

a first inlet substrate port in the first upper surface;

a first outlet substrate port in the first upper surface;

a first substrate fluid passageway extending between the first inlet substrate port and the first outlet substrate port in a smooth arc free of corners or angular walls;

each of the first outlet substrate port and the first inlet substrate port defined by a first substrate ring; and

for each of the first outlet substrate port and the first inlet substrate port, a first substrate channel formed in the first upper surface and surrounding the first substrate ring, an outer surface of the first substrate ring forming an inner surface of the first substrate channel;

a second substrate block mounted to the upper surface of the back plane, the second substrate block comprising:

a second upper surface;

a second inlet substrate port in the second upper surface;

a second outlet substrate port in the second upper surface;

a second substrate fluid passageway extending between the second inlet substrate port and the second outlet substrate port in a smooth arc free of corners or angular walls;

each of the second outlet substrate port and the second inlet substrate port defined by a second substrate ring; and

for each of the second outlet substrate port and the second inlet substrate port, a second substrate channel formed in the second upper surface and surrounding the second substrate ring, an outer surface of the second substrate ring forming an inner surface of the second substrate channel;

an active component selected from the group consisting of a flow controller, a pressure transducer, a flow measurement sensor, a pressure regulator, a valve, and a flow meter, the active component comprising:

a lower surface;

a component inlet port in the lower surface;

a component outlet port in the lower surface;

a component fluid passageway extending from the component inlet port to the component outlet port;

each of the component inlet port and the component outlet port defined by a component ring; and

for each of the component inlet port and the component outlet port, a component channel formed in the lower surface of the active component and surrounding the component ring, an outer surface of the component ring forming an inner surface of the component channel;

first and second seal rings, each of the first and second seal rings comprising:

an interior sleeve defining a sleeve fluid passageway extending along a longitudinal axis;

an outer ring connected to and surrounding the interior sleeve so that: (1) an annular upper sleeve groove is formed between an upper portion of the outer ring and an upper portion of the interior sleeve; and (2) an annular lower sleeve groove is formed between a lower portion of the outer ring and a lower portion of the interior sleeve;

the active component mounted to and bridging the first and second substrate blocks so that: (1) the first outlet substrate port and the component inlet port are aligned and the first seal ring nests in each of the first substrate channel of the first outlet substrate port and the component channel of the component inlet port, the first seal ring fluidly sealing the first

substrate fluid passageway and the component fluid passageway; (2) the second inlet substrate port and the component outlet port are aligned and the second seal ring nests in each of the second substrate channel of the second inlet port and the component channel of the component outlet port, the second seal ring fluidly sealing the second substrate fluid passageway and the component fluid passageway; and (3) the active component is spaced and isolated from the back plane.

2. The fluid delivery system of claim 1 wherein the first substrate ring extends into the annular lower sleeve groove of the first seal ring and the component ring extends into the annular upper sleeve groove of the first seal ring; and wherein the upper portion of the outer ring of the first seal ring extends into the component channel and the lower portion of the outer ring of the first seal ring extends into the first substrate channel.

3. The fluid delivery system of claim 2 further comprising:

the first upper surface of the first substrate block and the lower surface of the active component forming a horizontal interface;

the first seal ring sized so that: (1) the outer ring of the first seal ring is horizontally compressed within each of the component channel and the first substrate channel; and (2) the outer ring of the first seal ring is under no vertical compression.

4. The fluid delivery system of claim 3 further comprising:

the first seal ring further comprising a web connecting the interior sleeve and outer ring, the web disposed between the component ring and the first substrate ring;

the first seal ring sized so that the web is under no vertical compression.

5. The fluid delivery system of claim 1 further comprising:

the first seal ring being bilaterally symmetric about a central plane and the sleeve fluid passageway extending along a central axis;

the upper portion of the interior sleeve having an outer surface comprising an outwardly sloped portion; and

the lower portion of the interior sleeve having an outer surface comprising an outwardly sloped portion.

6. The fluid delivery system of claim 5 wherein the interior sleeve of the first seal ring has no horizontal surface.

7. The fluid delivery system of claim 5 further comprising:

the upper portion of the interior sleeve having an inner surface comprising an inwardly sloped portion;

the lower portion of the interior sleeve having an inner surface comprising an inwardly sloped portion.

8. The fluid delivery system of claim 5 wherein the first seal ring is sized so that the component ring exerts an interference force on the outwardly sloped portion of the upper portion of the interior sleeve and the first substrate ring exerts an interference force on the outwardly sloped portion of the lower portion of the interior sleeve.

9. The fluid delivery system of claim 1 further comprising:

the upper portion of the interior sleeve of the first seal ring having an outer surface comprising an outwardly sloped portion;

the lower portion of the interior sleeve of the first seal ring having an outer surface comprising an outwardly sloped portion;

the component ring comprising an inner surface having an inwardly sloped portion that mates with the outwardly sloped portion of the upper portion of the interior sleeve of the first seal ring; and

the first substrate ring comprising an inner surface having an inwardly sloped portion that mates with the outwardly sloped portion of the lower portion of the interior sleeve of the first seal ring.

10. The fluid delivery system of claim 1 further comprising a plurality of fasteners extending through a base of the active component and into the first substrate block to mount the active component to the first substrate block.

11. The fluid delivery system of claim 1 wherein the first substrate block is attached to the back plane, the first substrate block remaining fixed to the back plane when the active component is removed.

12. The fluid delivery system according to claim 1 wherein the first substrate block, the second substrate block, the first seal ring, and the second seal ring are formed of fluoropolymers.

13. A fluid delivery system comprising:

a back plane;

a first substrate block mounted to an upper surface of the back plane, the first substrate block comprising:

a first upper surface;

a first inlet substrate port in the first upper surface;

a first outlet substrate port in the first upper surface; and

a first substrate fluid passageway extending between the first inlet substrate port and the first outlet substrate port in a smooth arc free of corners or angular walls;

a second substrate block mounted to the upper surface of the back plane, the second substrate block comprising:

a second upper surface;

a second inlet substrate port in the second upper surface;

a second outlet substrate port in the second upper surface;

a second substrate fluid passageway extending between the second inlet substrate port and the second outlet substrate port in a smooth arc free of corners or angular walls;

an active component selected from the group consisting of a flow controller, a pressure transducer, a flow measurement sensor, a pressure regulator, a valve, and a flow meter, the active component comprising:

a lower surface;

a component inlet port in the lower surface;

a component outlet port in the lower surface; and

a component fluid passageway extending from the component inlet port to the component outlet port;

first and second seal rings, each of the first and second seal rings having an interior sleeve and an outer ring;

the active component mounted to and bridging the first and second substrate blocks so that: (1) the first outlet substrate port and the component inlet port are aligned and a horizontal interface is formed between the first upper surface and the lower surface, the first seal ring surrounds each of the first outlet substrate port and the component inlet port and fluidly seals the first substrate fluid passageway and the component fluid passageway, the first seal ring sized so that the outer ring of the first seal ring is horizontally compressed and under no vertical interference; (2) the second inlet substrate port and the component outlet port are aligned and a horizontal interface is formed between the second upper surface and the lower surface, and the second seal ring surrounds each of the second inlet substrate port and the component outlet port and fluidly seals the second substrate fluid passageway and the component fluid passageway, the second seal ring sized so that the outer ring of the second seal ring is horizontally compressed and under no vertical interference; and (3) the active component is spaced and isolated from the back plane.

14. The fluid delivery system according to claim 13 wherein the first seal ring further comprises a web extending radially inward from the outer ring; and wherein the web is under no vertical compression.

15. The fluid delivery system according to claim 14 further comprising:

the first substrate block comprising a first substrate ring defining the first outlet substrate port and a substrate channel formed in the first upper surface and surrounding the first substrate ring;

the active component comprising a component ring defining the component inlet port and a component channel formed in the lower surface and surrounding the component ring; and

the outer ring of the first seal ring extending into each of the substrate channel and the component channel, and wherein sidewalls of the substrate channel and the component channel horizontally compress the outer ring; and

the web disposed between the first substrate ring and the component ring.

16. The fluid delivery system according to claim 13 further comprising:

the first substrate block comprising a first substrate ring defining the first outlet substrate port;

the active component comprising a component ring defining the component inlet port;

the interior sleeve of the first seal ring comprising an outer surface comprising an outwardly sloped lower portion and an outwardly sloped upper portion;

the component ring comprising an inner surface having an inwardly sloped portion that mates with and exerts a compression force on the outwardly sloped portion of the upper portion of the interior sleeve of the first seal ring; and

the first substrate ring comprising an inner surface having an inwardly sloped portion that mates with and exerts a compression force on the outwardly sloped portion of the lower portion of the interior sleeve of the first seal ring.

17. The fluid delivery system according to claim 1 wherein the first substrate fluid passageway has a substantially constant radius.