POINT OF USE VALVE MANIFOLD FOR ~~ATOMIC LAYER DEPOSITION AND CHEMICAL VAPOR DEPOSITION REACTORS~~SEMICONDUCTOR FABRICATION EQUIPMENT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims benefit of priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application No. 61/660,606, entitled "POINT OF USE VALVE MANIFOLD FOR SEMICONDUCTOR FABRICATION EQUIPMENT" filed June 15, 2012, Attorney Docket No. NOVLP493P/NVLS003774P1 and U.S. Patent Application No. 13/626,717, entitled "POINT OF USE VALVE MANIFOLD FOR SEMICONDUCTOR FABRICATION EQUIPMENT" filed September 25, 2012, Attorney Docket No. NOVLP493/NVLS003774, both incorporated herein by reference in their entirety and for all purposes.

BACKGROUND

[0002] In an atomic layer deposition (ALD) tool, multiple precursors may be used to facilitate semiconductor wafer manufacturing processes. The precursors may form a deposition layer upon combining. To prevent premature deposition, i.e., within the gas or fluid lines leading to the process chamber, the precursors may be kept separate from each other.

SUMMARY OF THE INVENTION

[0003] The systems, methods and devices of the disclosure each have several innovative aspects, no single one of which is solely responsible for the desirable attributes disclosed herein. One innovative aspect of the subject matter described in this disclosure can be implemented in a variety of ways.

[0004] In some implementations, a valve manifold for use in a semiconductor processing tool may be provided. The valve manifold may include a manifold body. The manifold body may include a purge gas inlet, a manifold outlet, the manifold outlet located on a first side of the manifold body, a first valve interface, the first valve interface located on a second side of the manifold body different from the first side, and a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side. The first valve interface and the second valve interface may each include a first port, a second port, and a third port. The second port of the first valve interface may be configured to connect to a first process gas supply, and the third port of the first valve

manifold may also include a receptacle for a thermocouple to monitor the temperature of the manifold. Fig. 1L depicts locations of heater insert holes and a thermocouple mounting location on the manifold shown in Fig. 1A.

[0085] In some implementations, the manifold may include flow restrictors that are either built into the manifold or removably inserted into the manifold. Such flow restrictors may be configured to have flow restrictions ~~less~~ greater than the flow restrictions of the POU valves. In this manner, the flow restrictors may serve as the most-restricted choke points in the manifold assembly. This may be desirable to avoid flow restriction variability that may be seen if the POU valves are the most-restricted choke points. This may be particularly useful in implementations where multiple POU valve manifolds are used with a common precursor source and it is necessary to match the flows out of each POU valve manifold.

[0086] In some implementations, the precursor gas may be valved such that the precursor gas may be diverted to a pump rather than through the manifold. Such implementations may involve plumbing external to the POU valve manifold.

[0087] Another aspect of the invention is an apparatus configured to utilize the POU valve manifold described herein. A suitable apparatus may include one or more POU valve manifolds as described above, and a system controller having instructions for controlling the POU valves for those manifolds to perform operations in accordance with the gas flow requirements of a particular semiconductor process. The system controller will typically include one or more memory devices and one or more processors configured to execute the instructions so that the apparatus will control the POU valve manifold in accordance with the present invention, e.g., open/close the various POU valves in the manifold, monitor temperature levels in the manifold, and control any heater elements inserted into the manifold. Machine-readable media containing instructions for controlling process operations in accordance with the present invention may be coupled to the system controller.

[0088] The apparatus/process described hereinabove may be used in conjunction with lithographic patterning tools or processes, for example, for the fabrication or manufacture of semiconductor devices, displays, LEDs, photovoltaic panels and the like. Typically, though not necessarily, such tools/processes will be used or conducted together in a common fabrication facility. Lithographic patterning of a film typically comprises some or all of the following steps, each step enabled with a number of possible tools: (1) application of

Claims

1. A valve manifold for use in a semiconductor processing tool, comprising:

a manifold body;

a purge gas inlet;

a manifold outlet, the manifold outlet located on a first side of the manifold body;

a first valve interface, the first valve interface located on a second side of the manifold body different from the first side; and

a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side, wherein:

the first valve interface and the second valve interface each include a first port, a second port, and a third port,

the second port of the first valve interface is configured to connect to a first process gas supply,

the third port of the first valve interface is fluidly connected with the first port of the second valve interface via a first flow path internal to the manifold body and having no dead legs,

the second port of the second valve interface is fluidly connected with an interface configured to connect to a second process gas supply,

the third port of the second valve interface is fluidly connected with the manifold outlet by a second flow path internal to the manifold body and having no dead legs, and

the purge gas inlet is fluidly connected with the first port of the first valve interface by a third flow path internal to the manifold body and having no dead legs.

2. The valve manifold of claim 1, comprising:

a dump shunt outlet; and

a dump shunt valve interface, wherein:

the dump shunt valve interface includes a first port and a second port,

the first port of the dump shunt valve interface is fluidly connected with the second port of the second valve interface by a fourth flow path internal to the manifold body, and

the second port of the dump shunt valve interface is fluidly connected with the dump shunt outlet by a fifth flow path internal to the manifold body.

3. The valve manifold of claim 1, wherein the side of the manifold body where the manifold outlet is located is configured to be attached to mating features on a semiconductor processing chamber.

4. The valve manifold of claim 1, wherein:

there is overlap between a first reference volume defined by a projection of the outer boundary of the first valve interface in a direction substantially normal to the second side and a second reference volume defined by a projection of the outer boundary of the second valve interface in a direction substantially normal to the third side, and

the first valve interface and the second valve interface are offset from one another in a direction parallel to both the second side and the third side.

5. The valve manifold of claim 1, wherein the manifold body further includes one or more heater interfaces, each configured to accept a heating device.

6. The valve manifold of claim 5, wherein the one or more heater interfaces are receptacles within the manifold body.

7. An apparatus for delivery of a purge gas, a first process gas, and a second process gas to a semiconductor processing tool, the apparatus comprising:

a valve manifold, wherein the valve manifold comprises:

a manifold body,

a purge gas inlet,

a manifold outlet, the manifold outlet located on a first side of the manifold body,

a first valve interface, the first valve interface located on a second side of the manifold body different from the first side, and

a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side, wherein:

the first valve interface and the second valve interface each include a first port, a second port, and a third port,

the second port of the first valve interface is configured to connect to a first process gas supply,

the third port of the first valve interface is fluidly connected with the first port of the second valve interface via a first flow path internal to the manifold body and having no dead legs,

the second port of the second valve interface is configured to connect to a second process gas supply,

the third port of the second valve interface is fluidly connected with the manifold outlet by a second flow path internal to the manifold body and having no dead legs, and

the purge gas inlet is fluidly connected with the first port of the first valve interface by a third flow path internal to the manifold body and having no dead legs;

a first valve; and

a second valve, wherein the first valve and the second valve each include a valve body, a manifold interface area including a first valve port, a second valve port, and a third valve port, and a valve mechanism movable between an open state and a closed state, and wherein:

the first valve port is fluidly connected to the third valve port when the valve mechanism is in both the open state and in the closed state, and

the second valve port is fluidly connected to the first valve port and the third valve port when the valve mechanism is in the open state and is not fluidly connected to the first valve port and the third valve port when the valve mechanism is in the closed state, wherein:

the first valve port of the first valve is fluidly connected to the first port of the first valve interface,

the second valve port of the first valve is fluidly connected to the second port of the first valve interface,

the third valve port of the first valve is fluidly connected to the third port of the first valve interface,

the first valve port of the second valve is fluidly connected to the first port of the second valve interface,

the second valve port of the second valve is fluidly connected to the second port of the second valve interface, and

the third valve port of the second valve is fluidly connected to the third port of the second valve interface.

8. The apparatus of claim 7, wherein:

a first gasket provides a seal between the first valve port of the first valve and the first port of the first valve interface;

a second gasket provides a seal between the second valve port of the first valve and the second port of the first valve interface;

a third gasket provides a seal between the third valve port of the first valve and the third port of the first valve interface;

a fourth gasket provides a seal between the first valve port of the second valve and the first port of the second valve interface;

a fifth gasket provides a seal between the second valve port of the second valve and the second port of the second valve interface; and

a sixth gasket provides a seal between the third valve port of the second valve and the third port of the second valve interface.

9. The apparatus of claim 8, wherein the first gasket, the second gasket, the third gasket, the fourth gasket, the fifth gasket, and the sixth gasket are each selected from the group consisting of a C seal, a W seal, and an elastomeric seal.

10. The apparatus of claim 7, wherein the valve manifold further comprises:

a dump shunt outlet; and

a dump shunt valve interface, wherein:

the dump shunt valve interface includes a first port and a second port,

the first port of the dump shunt valve interface is fluidly connected with the second port of the second valve interface by a fourth flow path internal to the manifold body, and

the second port of the dump shunt valve interface is fluidly connected with the dump shunt outlet by a fifth flow path internal to the manifold body.

11. The apparatus of claim 7, wherein the side of the manifold body where the manifold outlet is located is configured to be mated with mating features on a semiconductor processing chamber.

12. The apparatus of claim 7, wherein:

there is overlap between a first reference volume defined by a projection of the outer boundary of the first valve interface in a direction substantially normal to the second side and a second reference volume defined by a projection of the outer boundary of the second valve interface in a direction substantially normal to the third side, and

the first valve interface and the second valve interface are offset from one another in a direction parallel to both the second side and the third side.

13. The apparatus of claim 7, wherein the manifold body further includes one or more heater interfaces, each configured to accept a heating device.

14. The apparatus of claim 13, wherein the one or more heater interfaces are receptacles within the manifold body.

15. The apparatus of claim 7, wherein the first flow path within the manifold body includes a flow restriction that is greater than either a maximum first flow restriction through the first valve or a maximum second flow restriction through the second valve when the valve mechanism of the first valve is in the open state and the valve mechanism of the second valve is in the open state, respectively.

16. The apparatus of claim 7, further comprising a temperature sensor configured to monitor the temperature of the manifold body.

17. A valve manifold for use in a semiconductor processing tool, comprising:

a manifold body;

a purge gas inlet;

a manifold outlet, the manifold outlet located on a first side of the manifold body;

a first valve interface, the first valve interface located on a second side of the manifold body different from the first side;

a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side; and

a purge valve interface, wherein:

the first valve interface and the second valve interface each include a first port, a second port, and a third port,

the second port of the first valve interface is configured to connect to a first process gas supply,

the third port of the first valve interface is fluidly connected with the first port of the second valve interface via a first flow path internal to the manifold body and having no dead legs,

the second port of the second valve interface is fluidly connected with an interface configured to connect to a second process gas supply,

the third port of the second valve interface is fluidly connected with the manifold outlet by a second flow path internal to the manifold body and having no dead legs,

the purge valve interface includes a first port and a second port,

the purge gas inlet is fluidly connected with the first port of the purge valve interface by a third flow path internal to the manifold body, and

the second port of the purge valve interface is fluidly connected with the first port of the first valve interface by a fourth flow path internal to the manifold body and having no dead legs.

18. The valve manifold of claim 17, comprising:

a dump shunt outlet; and

a dump shunt valve interface, wherein:

the dump shunt valve interface includes a first port and a second port,

the first port of the dump shunt valve interface is fluidly connected with the second port of the second valve interface by a fifth flow path internal to the manifold body, and

the second port of the dump shunt valve interface is fluidly connected with the dump shunt outlet by a sixth flow path internal to the manifold body.

19. The valve manifold of claim 17, wherein:

there is overlap between a first reference volume defined by a projection of the outer boundary of the first valve interface in a direction substantially normal to the second side and a second reference volume defined by a projection of the outer boundary of the second valve interface in a direction substantially normal to the third side, and

the first valve interface and the second valve interface are offset from one another in a direction parallel to both the second side and the third side.

20. An apparatus for delivery of a purge gas, a first process gas, and a second process gas to a semiconductor processing tool, the apparatus comprising:

a valve manifold, wherein the valve manifold comprises:

a manifold body,

a purge gas inlet,

a manifold outlet, the manifold outlet located on a first side of the manifold body,

a first valve interface, the first valve interface located on a second side of the manifold body different from the first side,

a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side,

a purge valve interface, wherein:

the first valve interface and the second valve interface each include a first port, a second port, and a third port,

the second port of the first valve interface is configured to connect to a first process gas supply,

the third port of the first valve interface is fluidly connected with the first port of the second valve interface via a first flow path internal to the manifold body and having no dead legs,

the second port of the second valve interface is configured to connect to a second process gas supply,

the third port of the second valve interface is fluidly connected with the manifold outlet by a second flow path internal to the manifold body and having no dead legs,

the purge valve interface includes a first port and a second port,

the purge gas inlet is fluidly connected with the first port of the purge valve interface by a third flow path internal to the manifold body, and

the second port of the purge valve interface is fluidly connected with the first port of the first valve interface by a fourth flow path internal to the manifold body and having no dead legs;

a first valve; and

a second valve, wherein the first valve and the second valve each include a valve body, a manifold interface area including a first valve port, a second valve port, and a third valve port, and a valve mechanism movable between an open state and a closed state, and wherein:

the first valve port is fluidly connected to the third valve port when the valve mechanism is in both the open state and in the closed state, and

the second valve port is fluidly connected to the first valve port and the third valve port when the valve mechanism is in the open state and is not fluidly connected to the first valve port and the third valve port when the valve mechanism is in the closed state, wherein:

the first valve port of the first valve is fluidly connected to the first port of the first valve interface,

the second valve port of the first valve is fluidly connected to the second port of the first valve interface,

the third valve port of the first valve is fluidly connected to the third port of the first valve interface,

the first valve port of the second valve is fluidly connected to the first port of the second valve interface,

the second valve port of the second valve is fluidly connected to the second port of the second valve interface, and

the third valve port of the second valve is fluidly connected to the third port of the second valve interface.

21. The apparatus of claim 20, wherein the valve manifold further comprises:

a dump shunt outlet; and

a dump shunt valve interface, wherein:

the dump shunt valve interface includes a first port and a second port,

the first port of the dump shunt valve interface is fluidly connected with the second port of the second valve interface by a fifth flow path internal to the manifold body, and

the second port of the dump shunt valve interface is fluidly connected with the dump shunt outlet by a sixth flow path internal to the manifold body.

22. The apparatus of claim 20, wherein:

there is overlap between a first reference volume defined by a projection of the outer boundary of the first valve interface in a direction substantially normal to the second side and a second reference volume defined by a projection of the outer boundary of the second valve interface in a direction substantially normal to the third side, and

the first valve interface and the second valve interface are offset from one another in a direction parallel to both the second side and the third side.

23. A valve manifold for use in a semiconductor processing tool, comprising:

a manifold body;

a purge gas inlet;

a manifold outlet, the manifold outlet located on a first side of the manifold body;

a first valve interface, the first valve interface located on a second side of the manifold body different from the first side;

a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side;

a dump shunt outlet; and

a dump shunt valve interface, wherein:

the first valve interface and the second valve interface each include a first port, a second port, and a third port,

the second port of the first valve interface is configured to connect to a first process gas supply,

the third port of the first valve interface is fluidly connected with the first port of the second valve interface via a first flow path internal to the manifold body and having no dead legs,

the second port of the second valve interface is fluidly connected with an interface configured to connect to a second process gas supply,

the third port of the second valve interface is fluidly connected with the manifold outlet by a second flow path internal to the manifold body and having no dead legs,

the dump shunt valve interface includes a first port and a second port,

the first port of the dump shunt valve interface is fluidly connected with the second port of the second valve interface by a third flow path internal to the manifold body, and

the second port of the dump shunt valve interface is fluidly connected with the dump shunt outlet by a fourth flow path internal to the manifold body.

24. The valve manifold of claim 23, wherein the purge gas inlet is fluidly connected with the first port of the first valve interface by a fifth flow path internal to the manifold body and having no dead legs.

25. The valve manifold of claim 23, comprising a purge valve interface, wherein:

the purge valve interface includes a first port and a second port;

the purge gas inlet is fluidly connected with the first port of the purge valve interface by a fifth flow path internal to the manifold body; and

the second port of the purge valve interface is fluidly connected with the first port of the first valve interface by a sixth flow path internal to the manifold body and having no dead legs.

26. The valve manifold of claim 23, wherein:

there is overlap between a first reference volume defined by a projection of the outer boundary of the first valve interface in a direction substantially normal to the second side and a second reference volume defined by a projection of the outer boundary of the second valve interface in a direction substantially normal to the third side, and

the first valve interface and the second valve interface are offset from one another in a direction parallel to both the second side and the third side.

27. An apparatus for delivery of a purge gas, a first process gas, and a second process gas to a semiconductor processing tool, the apparatus comprising:

a valve manifold, wherein the valve manifold comprises:

a manifold body,

a purge gas inlet,

a manifold outlet, the manifold outlet located on a first side of the manifold body,

a first valve interface, the first valve interface located on a second side of the manifold body different from the first side,

a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side,

a dump shunt outlet, and

a dump shunt valve interface, wherein:

the first valve interface and the second valve interface each include a first port, a second port, and a third port,

the second port of the first valve interface is configured to connect to a first process gas supply,

the third port of the first valve interface is fluidly connected with the first port of the second valve interface via a first flow path internal to the manifold body and having no dead legs,

the second port of the second valve interface is configured to connect to a second process gas supply,

the third port of the second valve interface is fluidly connected with the manifold outlet by a second flow path internal to the manifold body and having no dead legs,

the dump shunt valve interface includes a first port and a second port,

the first port of the dump shunt valve interface is fluidly connected with the second port of the second valve interface by a third flow path internal to the manifold body, and

the second port of the dump shunt valve interface is fluidly connected with the dump shunt outlet by a fourth flow path internal to the manifold body;

a first valve; and

a second valve, wherein the first valve and the second valve each include a valve body, a manifold interface area including a first valve port, a second valve port, and a third valve port, and a valve mechanism movable between an open state and a closed state, and wherein:

the first valve port is fluidly connected to the third valve port when the valve mechanism is in both the open state and in the closed state, and

the second valve port is fluidly connected to the first valve port and the third valve port when the valve mechanism is in the open state and is not fluidly connected to the first valve port and the third valve port when the valve mechanism is in the closed state, wherein:

the first valve port of the first valve is fluidly connected to the first port of the first valve interface,

the second valve port of the first valve is fluidly connected to the second port of the first valve interface,

the third valve port of the first valve is fluidly connected to the third port of the first valve interface,

the first valve port of the second valve is fluidly connected to the first port of the second valve interface,

the second valve port of the second valve is fluidly connected to the second port of the second valve interface, and

the third valve port of the second valve is fluidly connected to the third port of the second valve interface.

28. The apparatus of claim 27, wherein the purge gas inlet is fluidly connected with the first port of the first valve interface by a third flow path internal to the manifold body and having no dead legs.

29. The apparatus of claim 27, wherein the valve manifold further comprises a purge valve interface, wherein:

the purge valve interface includes a first port and a second port;

the purge gas inlet is fluidly connected with the first port of the purge valve interface by a fifth flow path internal to the manifold body; and

the second port of the purge valve interface is fluidly connected with the first port of the first valve interface by a sixth flow path internal to the manifold body and having no dead legs.

30. The apparatus of claim 27, wherein:

there is overlap between a first reference volume defined by a projection of the outer boundary of the first valve interface in a direction substantially normal to the second side and a second reference volume defined by a projection of the outer boundary of the second valve interface in a direction substantially normal to the third side, and

the first valve interface and the second valve interface are offset from one another in a direction parallel to both the second side and the third side.

CLAIMS

What is claimed is:

1. A valve manifold for use in a semiconductor processing tool, comprising:

a manifold body;

a purge gas inlet;

a manifold outlet, the manifold outlet located on a first side of the manifold body;

a first valve interface, the first valve interface located on a second side of the manifold body different from the first side; and

a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side, wherein:

the first valve interface and the second valve interface each include a first port, a second port, and a third port,

the second port of the first valve interface is configured to connect to a first process gas supply,

the third port of the first valve interface is fluidly connected with the first port of the second valve interface via a first flow path internal to the manifold body and having no dead legs,

the second port of the second valve interface is fluidly connected with an interface configured to connect to a second process gas supply, and

the third port of the second valve interface is fluidly connected with the manifold outlet by a second flow path internal to the manifold body and having no dead legs.

2. The valve manifold of claim 1, wherein the purge gas inlet is fluidly connected with the first port of the first valve interface by a third flow path internal to the manifold body and having no dead legs.

3. The valve manifold of either claim 1 or claim 2, comprising a purge valve interface, wherein:

the purge valve interface includes a first port and a second port;

the purge gas inlet is fluidly connected with the first port of the purge valve interface by a third flow path internal to the manifold body; and

the second port of the purge valve interface is fluidly connected with the first port of the first valve interface by a fourth flow path internal to the manifold body and having no dead legs.

4. The valve manifold of any one of claims 1 through 3, comprising:

a dump shunt outlet; and

a dump shunt valve interface, wherein:

the dump shunt valve interface includes a first port and a second port,

the first port of the dump shunt valve interface is fluidly connected with the second port of the second valve interface by a fifth flow path internal to the manifold body, and

the second port of the dump shunt valve interface is fluidly connected with the dump shunt outlet by a sixth flow path internal to the manifold body.

5. The valve manifold of any one of claims 1 through 4, wherein the side of the manifold body where the manifold outlet is located is configured to be attached to mating features on a semiconductor processing chamber.

6. The valve manifold of any one of claims 1 through 5, wherein there is overlap between a first reference volume defined by a projection of the outer boundary of the first valve interface in a direction substantially normal to the second side and a second reference volume defined by a projection of the outer boundary of the second valve interface in a direction substantially normal to the third side.

7. The valve manifold of any one of claims 1 through 6, wherein the manifold body further includes one or more heater interfaces, each configured to accept a heating device.

8. The valve manifold of claim 7, wherein the one or more heater interfaces are receptacles within the manifold body.

9. An apparatus for delivery of a purge gas, a first process gas, and a second process gas to a semiconductor processing tool, the apparatus comprising:

a valve manifold, wherein the valve manifold comprises:

a manifold body,

a purge gas inlet,

a manifold outlet, the manifold outlet located on a first side of the manifold body,

a first valve interface, the first valve interface located on a second side of the manifold body different from the first side, and

a second valve interface, the second valve interface located on a third side of the manifold body different from the first side and the second side, wherein:

the first valve interface and the second valve interface each include a first port, a second port, and a third port,

the second port of the first valve interface is configured to connect to a first process gas supply,

the third port of the first valve interface is fluidly connected with the first port of the second valve interface via a first flow path internal to the manifold body and having no dead legs,

the second port of the second valve interface is configured to connect to a second process gas supply, and

the third port of the second valve interface is fluidly connected with the manifold outlet by a second flow path internal to the manifold body and having no dead legs;

a first valve; and

a second valve, wherein the first valve and the second valve each include a valve body, a manifold interface area including a first valve port, a second valve port, and a third valve port, and a valve mechanism movable between an open state and a closed state, and wherein:

the first valve port is fluidly connected to the third valve port when the valve mechanism is in both the open state and in the closed state, and

the second valve port is fluidly connected to the first valve port and the third valve port when the valve mechanism is in the open state and is not fluidly connected to the first valve port and the third valve port when the valve mechanism is in the closed state, wherein:

the first valve port of the first valve is fluidly connected to the first port of the first valve interface,

the second valve port of the first valve is fluidly connected to the second port of the first valve interface,

the third valve port of the first valve is fluidly connected to the third port of the first valve interface,

the first valve port of the second valve is fluidly connected to the first port of the second valve interface,

the second valve port of the second valve is fluidly connected to the second port of the second valve interface, and

the third valve port of the second valve is fluidly connected to the third port of the second valve interface.

10. The apparatus of claim 9, wherein:

a first gasket provides a seal between the first valve port of the first valve and the first port of the first valve interface;

a second gasket provides a seal between the second valve port of the first valve and the second port of the first valve interface;

a third gasket provides a seal between the third valve port of the first valve and the third port of the first valve interface;

a fourth gasket provides a seal between the first valve port of the second valve and the first port of the second valve interface;

a fifth gasket provides a seal between the second valve port of the second valve and the second port of the second valve interface; and

a sixth gasket provides a seal between the third valve port of the second valve and the third port of the second valve interface.

11. The apparatus of either claim 9 or claim 10, wherein the first gasket, the second gasket, the third gasket, the fourth gasket, the fifth gasket, and the sixth gasket are each selected from the group consisting of a C seal, a W seal, and an elastomeric seal.

12. The apparatus of any one of claims 9 through 11, wherein the purge gas inlet is fluidly connected with the first port of the first valve interface by a third flow path internal to the manifold body and having no dead legs.

13. The apparatus of any one of claims 9 through 12, wherein the valve manifold further comprises a purge valve interface, wherein:

the purge valve interface includes a first port and a second port;

the purge gas inlet is fluidly connected with the first port of the purge valve interface by a third flow path internal to the manifold body; and

the second port of the purge valve interface is fluidly connected with the first port of the first valve interface by a fourth flow path internal to the manifold body and having no dead legs.

14. The apparatus of any one of claims 9 through 13, wherein the valve manifold further comprises:

a dump shunt outlet; and

a dump shunt valve interface, wherein:

the dump shunt valve interface includes a first port and a second port,

the first port of the dump shunt valve interface is fluidly connected with the second port of the second valve interface by a fifth flow path internal to the manifold body, and

the second port of the dump shunt valve interface is fluidly connected with the dump shunt outlet by a sixth flow path internal to the manifold body.

15. The apparatus of any one of claims 9 through 14, wherein the side of the manifold body where the manifold outlet is located is configured to be mated with mating features on a semiconductor processing chamber.

16. The apparatus of any one of claims 9 through 15, wherein there is overlap between a first reference volume defined by a projection of the outer boundary of the first valve interface in a direction substantially normal to the second side and a second reference volume defined by a projection of the outer boundary of the second valve interface in a direction substantially normal to the third side.

17. The apparatus of any one of claims 9 through 16, wherein the manifold body further includes one or more heater interfaces, each configured to accept a heating device.

18. The apparatus of any one of claims 9 through 17, wherein the one or more heater interfaces are receptacles within the manifold body.

19. The apparatus of any one of claims 9 through 18, wherein the first flow path within the manifold body includes a flow restriction that is greater than either a maximum first flow restriction through the first valve or a maximum second flow restriction through the second valve when the valve mechanism of the first valve is in the open state and the valve mechanism of the second valve is in the open state, respectively.

20. The apparatus of any one of claims 9 through 19, wherein the second flow path within the manifold body includes a flow restriction that is greater than either a maximum first flow restriction through the first valve or a maximum second flow restriction through the second valve when the valve mechanism of the first valve is in the open state and the valve mechanism of the second valve is in the open state, respectively.

21. The apparatus of any one of claims 9 through 20, further comprising a temperature sensor configured to monitor the temperature of the manifold body.