temperature, in which the second flowpath fluidically connects a junction point to the second showerhead.

[0033] In some embodiments, the maintaining the first flow element at the first temperature may include maintaining the first flowpath at a first flow conductance, and the maintaining the second flow element at the second temperature may include maintaining the second flowpath at a second flow conductance different than the first flow conductance.

[0034] In some embodiments, the maintaining the first flow element at the first temperature may include maintaining the first flowpath at a first flow conductance, and the maintaining the second flow element at the second temperature may include maintaining the second flowpath at a second flow conductance substantially the same as the first flow conductance.

[0035] In some embodiments, the maintaining the first flow element at the first temperature may include heating the first element, and the maintaining the second flow element at the second temperature may include not heating the second element.

[0036] In some embodiments, the maintaining the first flow element at the first temperature may include heating the first element, and the maintaining the second flow element at the second temperature may include heating the second element.

[0037] In some embodiments, the method may further include providing, before providing the first substrate and the second substrate, a third substrate onto the first pedestal, providing, before providing the first substrate and the second substrate, a fourth substrate onto the second pedestal, and simultaneously depositing a third layer of material onto the third substrate and a fourth layer of material onto the fourth substrate while not maintaining the first flow element at the first temperature and not maintaining the second flow element at the second temperature. A first nonuniformity between a property of the first layer of material on the first substrate and the property of the second layer of material on the second substrate, may be smaller than a second nonuniformity between the property of the third layer of material on the third substrate and the property of the fourth layer of material on the fourth substrate.

CLAIMS

1. A multi-station processing apparatus, the apparatus comprising:

a processing chamber;

a plurality of process stations in the processing chamber that each include a showerhead having a gas inlet;

a gas delivery system including a junction point and a plurality of flowpaths, wherein each flowpath:

includes at least one flow element, the at least one flow element comprising a valve,

includes at least one temperature control unit directly contacting the at least one flow element and controllable to change the temperature of that at least one flow element, and

fluidically connects one corresponding gas inlet of a process station to the junction point such that each process station of the plurality of process stations is fluidically connected to the junction point by a different flowpath and in a manner that the valve is fluidically interposed between the junction point and the one corresponding gas inlet.

2. The apparatus of claim 1, wherein the at least one temperature control unit is controllable to change, via a temperature change, a flow conductance of the at least one flow element with which it directly contacts.

3. The apparatus of claim 1, wherein the at least one temperature control unit includes a heating element configured to heat the at least one flow element with which it directly contacts.

4. The apparatus of claim 3, wherein the heating element includes a resistive heating element, a thermoelectric heater, and/or a fluid conduit configured to flow a heating fluid within the fluid conduit.

5. The apparatus of claim 1, wherein:

each showerhead further includes a faceplate and a other temperature control unit directly contacting the showerhead and controllable to change the temperature of a portion of the showerhead, and

each flowpath further fluidically connects the showerhead faceplate to the junction point.

6. The apparatus of claim 5, wherein the other temperature control unit directly contacts a stem of the showerhead and is controllable to change the temperature of the stem.

7. The apparatus of claim 5, wherein the other temperature control unit directly contacts the faceplate and is controllable to change the temperature of the faceplate.

8. The apparatus of claim 5, wherein:

the showerhead further includes a back plate, and

the other temperature control unit directly contacts the back plate and is controllable to change the temperature of the back plate.

9. The apparatus of claim 5, wherein the showerhead is a flush-mount showerhead.

10. The apparatus of claim 1, wherein the at least one temperature control unit is positioned at least partially inside the at least one flow element on which it is positioned.

11. The apparatus of claim 1, wherein the at least one temperature control unit of each flowpath is controllable to heat the valve to change a flow conductance of the valve.

12. The apparatus of claim 1, wherein:

the at least one flow element of each flowpath further comprises a monoblock, and

the at least one temperature control unit of each flowpath is controllable to heat the monoblock to change a flow conductance of the monoblock.

13. The apparatus of claim 1, wherein:

the at least one flow element of each flowpath further comprises a gas line, and

the at least one temperature control unit of each flowpath is controllable to heat the gas line to change a flow conductance of the gas line.

14. The apparatus of claim 13, wherein the junction point is a mixing bowl.

15. The apparatus of claim 1, wherein:

the at least one flow element of each flowpath further comprises a fitting, and

the at least one temperature control unit of each flowpath is controllable to heat the fitting to change a flow conductance of the fitting.

16. The apparatus of claim 15, wherein the fitting is a tee fitting.

17. The apparatus of claim 1, wherein:

the at least one flow element is at least two flow elements,

the at least one temperature control unit is at least two temperature control units, and

each temperature control unit in each flowpath directly contacts a different flow element of that flowpath.

18. The apparatus of claim 1, further comprising a controller configured to control the multi-station processing apparatus to deposit a material onto substrates respectively at the plurality of process stations, wherein:

for a first flowpath fluidically connected to a first station of the plurality of process stations, a first temperature control unit directly contacts a first flow element,

for a second flowpath fluidically connected to a second station of the plurality of process stations, a second temperature control unit directly contacts a second flow element, and

the controller comprises control logic for:

providing a substrate at each of the process stations,

simultaneously depositing a first layer of material onto a first substrate at the first process station and a second layer of material onto a second substrate at the second process station, and

maintaining, during at least a portion of the depositing, the first flow element at a first temperature and the second flow element at a second temperature different than the first temperature.

19. The apparatus of claim 18, wherein:

the maintaining the first flow element at the first temperature comprises causing the first temperature control unit to heat the first flow element to the first temperature, and

the maintaining the second flow element at the second temperature comprises not causing the second temperature control unit to heat the second flow element.

20. The apparatus of claim 18, wherein:

the maintaining the first flow element at the first temperature comprises causing the first temperature control unit to heat the first flow element to the first temperature, and

the maintaining the second flow element at the second temperature comprises causing the second temperature control unit to heat the second flow element to the second temperature.

21. The apparatus of claim 18, wherein the controller further comprises control logic for:

maintaining, during at least a second portion of the depositing, the first flow element at a third temperature different than the first temperature, and the second flow element at a fourth temperature different than the second temperature.

22. The apparatus of claim 18, wherein:

during the maintaining the first flow element at the first temperature, the first flowpath has a first flow conductance, and

during the maintaining the second flow element at the second temperature, the second flowpath has a second flow conductance different than the first flow conductance.

23. The apparatus of claim 18, wherein:

during the maintaining the first flow element at the first temperature, the first flowpath has a first flow conductance, and

during the maintaining the second flow element at the second temperature, the second flowpath has a second flow conductance substantially equal to the first flow conductance.

24. The apparatus of claim 18, wherein:

the first layer of material deposited on the first substrate has a first value of a property, and

the second layer of material deposited on the second substrate has a second value of the property substantially the same as the first value.

25. The apparatus of claim 24, wherein the property is selected from the group consisting of a wet etch rate, a dry etch rate, a composition, a thickness, a density, an amount of cross-linking, a reaction completion, a stress, a refractive index, a dielectric constant, a hardness, an etch selectivity, a stability, and a hermeticity.

26. The apparatus of claim 18, wherein:

the first layer of material deposited on the first substrate has a first value of a property, and

the second layer of material deposited on the first substrate has a second value of the property different than the first value.

27. The apparatus of claim 18, wherein the depositing further includes one or more of: a temperature soak of the substrates, indexing, flowing a precursor, flowing a purge gas, flowing a reactant gas, generating a plasma, and activating the precursor on the substrates to thereby deposit the material onto the substrates.

28. A method of depositing material onto substrates in a multi-station processing apparatus having a first station with a first showerhead and a second station with a second showerhead, the method comprising:

providing a first substrate onto a first pedestal of the first station;

providing a second substrate onto a second pedestal of the second station;

simultaneously depositing a first layer of material onto the first substrate and a second layer of material onto the second substrate; and

maintaining, during at least a portion of the simultaneous depositing:

a first flow element of a first flowpath at a first temperature, wherein the first flowpath fluidically connects a junction point to the first showerhead such that the first flow element is fluidically interposed between the junction point and the first showerhead, and

a second flow element of a second flowpath at a second temperature different than the first temperature, wherein the second flowpath fluidically connects the junction point to the second showerhead such that the second flow element is fluidically interposed between the junction point and the second showerhead,

wherein at least one of the first flow element and the second flow element comprises a valve.

29. The method of claim 28, wherein:

the maintaining the first flow element at the first temperature comprises maintaining the first flowpath at a first flow conductance, and

the maintaining the second flow element at the second temperature comprises maintaining the second flowpath at a second flow conductance different than the first flow conductance.

30. The method of claim 28, wherein:

the maintaining the first flow element at the first temperature comprises maintaining the first flowpath at a first flow conductance, and

the maintaining the second flow element at the second temperature comprises maintaining the second flowpath at a second flow conductance substantially the same as the first flow conductance.

31. The method of claim 28, wherein:

the maintaining the first flow element at the first temperature comprises heating the first flow element, and

the maintaining the second flow element at the second temperature comprises not heating the second flow element.

32. The method of claim 28, wherein:

the maintaining the first flow element at the first temperature comprises heating the first flow element, and

the maintaining the second flow element at the second temperature comprises heating the second flow element.

33. The method of claim 28, further comprising:

providing, before providing the first substrate onto the first pedestal and the second substrate onto the second pedestal, a third substrate onto the first pedestal;

providing, before providing the first substrate onto the first pedestal and the second substrate onto the second pedestal, a fourth substrate onto the second pedestal; and

simultaneously depositing a third layer of material onto the third substrate and a fourth layer of material onto the fourth substrate while not maintaining the first flow element at the first temperature and not maintaining the second flow element at the second temperature, wherein:

a first nonuniformity between a property of the first layer of material on the first substrate and the property of the second layer of material on the second substrate, is smaller than a second nonuniformity between the property

of the third layer of material on the third substrate and the property of the fourth layer of material on the fourth substrate.