CLAIMS

1. A substrate processing system comprising:

a pedestal configured to support a substrate;

a resistive heater disposed in the pedestal, wherein the resistive heater is configured to heat the substrate; and

a radiative heater disposed in the pedestal, wherein the radiative heater is configured to heat the substrate.

2. The substrate processing system of claim 1 wherein:

the resistive heater comprises one or more resistive heating elements; and

the radiative heater comprises a plurality of optical elements.

3. The substrate processing system of claim 2 wherein the optical elements comprise light emitting diodes.

4. The substrate processing system of claim 1 wherein:

the pedestal comprises a base portion and a stem portion; and

the resistive heater and the radiative heater are disposed in the base portion of the pedestal.

5. The substrate processing system of claim 4 wherein the base portion is cylindrical and wherein the resistive heater and the radiative heater extend from a center region of the base portion towards an outer diameter of the base portion.

6. The substrate processing system of claim 4 wherein:

the radiative heater is disposed proximate to a surface of the base portion on which the substrate is arranged; and

the resistive heater is disposed under the radiative heater in the base portion.

7. The substrate processing system of claim 4 wherein the resistive and radiative heaters are coplanar.

8. The substrate processing system of claim 4 wherein:

the base portion of the pedestal is cylindrical;

the resistive heater comprises a plurality of resistive heating elements arranged in first concentric circles in the base portion;

the radiative heater comprises a plurality of optical elements arranged in second concentric circles in the base portion; and

the first and second concentric circles are interleaved with each other and extend from a center region of the base portion towards an outer diameter of the base portion.

9. The substrate processing system of claim 8 wherein:

the radiative heater is disposed proximate to a surface of the base portion on which the substrate is arranged; and

the resistive heater is disposed under the radiative heater in the base portion.

10. The substrate processing system of claim 8 wherein the resistive and radiative heaters are coplanar.

11. The substrate processing system of claim 4 wherein:

the base portion of the pedestal is cylindrical;

the resistive heater comprises a plurality of resistive heating elements arranged in concentric circles in the base portion;

the radiative heater comprises a plurality of optical elements arranged in radially extending spokes in the base portion; and

the concentric circles and the radially extending spokes extend from a center region of the base portion towards an outer diameter of the base portion.

12. The substrate processing system of claim 11 wherein:

the radiative heater is disposed proximate to a surface of the base portion on which the substrate is arranged; and

the resistive heater is disposed under the radiative heater in the base portion.

13. The substrate processing system of claim 4 wherein:

the base portion of the pedestal is cylindrical;

the resistive heater comprises a plurality of resistive heating elements arranged in first radially extending spokes in the base portion;

the radiative heater comprises a plurality of optical elements arranged in second radially extending spokes in the base portion; and

the first and second radially extending spokes are interleaved with each other and extend from a center region of the base portion towards an outer diameter of the base portion.

14. The substrate processing system of claim 13 wherein:

the radiative heater is disposed proximate to a surface of the base portion on which the substrate is arranged; and

the resistive heater is disposed under the radiative heater in the base portion.

15. The substrate processing system of claim 14 wherein the resistive and radiative heaters are coplanar.

16. The substrate processing system of claim 4 further comprising a cooling channel disposed in the base portion under the resistive and radiative heaters.

17. The substrate processing system of claim 4 wherein the resistive heater comprises a plurality of resistive heating elements and the radiative heater comprises a plurality of optical elements, the substrate processing system further comprising a controller configured to control different ones of the resistive heating elements and different ones of the optical elements in a temporally staggered manner.

18. The substrate processing system of claim 17 further comprising:

a shaft disposed through the stem portion and the base portion; and

an actuator coupled to the shaft,

wherein the controller is configured to move the substrate relative to the pedestal.

19. The substrate processing system of claim 4 wherein the radiative heater comprises:

a plurality of optical elements arranged on a printed circuit board (PCB);

one or more drivers arranged on the PCB, wherein the one or more drivers is configured to control the optical elements; and

a window covering the optical elements, the window being optically transparent and sealingly attached to the PCB.

20. The substrate processing system of claim 19 wherein the pedestal further comprises:

a shaft disposed through centers of the stem portion, the base portion, and the PCB, wherein the shaft comprises a conduit configured to receive a gas and a plurality of holes in fluid communication with the conduit near a first end of the shaft proximate to the radiative heater; and

an actuator coupled to a second end of the shaft, wherein the actuator is configured to move the substrate perpendicularly relative to a plane in which the base portion lies,

wherein the plurality of holes supply the gas radially over the window when the shaft is raised above the window.

21. The substrate processing system of claim 1 wherein:

the pedestal comprises a base portion and a stem portion;

the resistive heater is disposed in the base portion of the pedestal; and

the radiative heater is disposed under the base portion and around the stem portion proximate to the base portion.

22. The substrate processing system of claim 21 wherein the base portion is cylindrical and wherein the resistive heater and the radiative heater extend from a center region of the base portion towards an outer diameter of the base portion.

23. The substrate processing system of claim 21 wherein the radiative heater comprises:

a plurality of optical elements arranged on a printed circuit board (PCB);

one or more drivers arranged on the PCB, wherein the one or more drivers is configured to control the optical elements;

a plurality of lenses disposed on the optical elements; and

a window covering the optical elements and the lenses, the window being optically transparent and sealingly attached to the PCB.

24. The substrate processing system of claim 21 wherein:

the base portion of the pedestal is cylindrical;

the resistive heater comprises a plurality of resistive heating elements arranged in first concentric circles in the base portion;

the radiative heater comprises a plurality of optical elements arranged in second concentric circles in the base portion; and

the first and second concentric circles are interleaved with each other and extend from a center region of the base portion towards an outer diameter of the base portion.

25. The substrate processing system of claim 21 wherein:

the base portion of the pedestal is cylindrical;

the resistive heater comprises a plurality of resistive heating elements arranged in concentric circles in the base portion;

the radiative heater comprises a plurality of optical elements arranged in radially extending spokes in the base portion; and

the concentric circles and the radially extending spokes extend from a center region of the base portion towards an outer diameter of the base portion.

26. The substrate processing system of claim 21 wherein:

the base portion of the pedestal is cylindrical;

the resistive heater comprises a plurality of resistive heating elements arranged in first radially extending spokes in the base portion;

the radiative heater comprises a plurality of optical elements arranged in second radially extending spokes in the base portion; and

the first and second radially extending spokes are interleaved with each other and extend from a center region of the base portion towards an outer diameter of the base portion.

27. The substrate processing system of claim 21 further comprising a cooling channel disposed in the base portion under the resistive heater.

28. The substrate processing system of claim 21 wherein the resistive heater comprises a plurality of resistive heating elements and the radiative heater comprises a plurality of optical elements, the substrate processing system further comprising a controller configured to control different ones of the resistive heating elements and different ones of the optical elements in a temporally staggered manner.

29. The substrate processing system of claim 28 further comprising:

a shaft disposed through the stem portion and the base portion; and

an actuator coupled to the shaft,

wherein the controller is configured to move the substrate relative to the pedestal.