CLAIMS

1. A system to process a semiconductor substrate, comprising:

a substrate support assembly configured to support the semiconductor substrate, including:

M resistive heaters respectively arranged in M zones in a layer of the substrate support assembly, the layer being adjacent to the semiconductor substrate, where M is an integer greater than 1; and

N temperature sensors arranged at N locations in the layer, where N is an integer greater than 1 and less than or equal to M; and

a controller configured to control one or more of the M resistive heaters based on a temperature sensed by one of the N temperature sensors and average temperatures of one or more of the M zones.

2. The system of claim 1 wherein the M zones include:

a first circular zone located at a center region of the layer;

a second annular zone surrounding the first circular zone;

a first set of zones located in a first annular region surrounding the second annular zone; and

a second set of zones located in a second annular region surrounding the first annular region.

3. The system of claim 2 wherein the first set of zones is rotated at an angle relative to the second set of zones.

4. The system of claim 2 wherein the first set of zones is rotated at a forty five degree angle relative to the second set of zones.

5. The system of claim 2 wherein the first and second annular regions have different widths.

6. The system of claim 2 wherein the second annular zone has a different width than each of the first and second annular regions.

7. The system of claim 2 wherein each of the first and second sets of zones includes four zones.

8. The system of claim 2 wherein the N temperature sensors include:

a first temperature sensor located in the first circular zone;

a first pair of temperature sensors located at a first boundary between the second annular zone and the first set of zones along a first diameter of the layer; and

a second pair of temperature sensors located at a second boundary between the first set of zones and the second set of zones along a second diameter of the layer,

wherein the first temperature sensor is located at an intersection of the first and second diameters.

9. The system of claim 8 wherein:

locations of the first and second pairs of temperature sensors correspond to vertices of a parallelogram; and

the first and second diameters form diagonals of the parallelogram.

10. The system of claim 1 wherein the controller is configured to control one of the M resistive heaters independently of others of the M resistive heaters.

11. The system of claim 1 wherein the controller is configured to control one or more of the M resistive heaters based on a target temperature profile of the semiconductor substrate.

12. A substrate support assembly to support a semiconductor substrate, comprising:

a baseplate including a layer adjacent to the semiconductor substrate;

M resistive heaters respectively arranged in M zones in the layer, where M is an integer greater than 1, and wherein the M zones include:

a first circular zone located at a center region of the layer;

a second annular zone surrounding the first circular zone;

a first set of zones located in a first annular region surrounding the second annular zone; and

a second set of zones located in a second annular region surrounding the first annular region; and

N temperature sensors arranged at N locations in the layer, where N is an integer greater than 1 and less than or equal to M, and wherein the N temperature sensors include:

a first pair of temperature sensors located at a first boundary between the second annular zone and the first set of zones along a first diameter of the layer;

a second pair of temperature sensors located at a second boundary between the first set of zones and the second set of zones along a second diameter of the layer; and

a first temperature sensor located in the first circular zone.

13. The substrate support assembly of claim 12 wherein:

locations of the first and second pairs of temperature sensors correspond to vertices of a parallelogram; and

the first and second diameters form diagonals of the parallelogram.

14. The substrate support assembly of claim 12 wherein the first set of zones is rotated at an angle relative to the second set of zones.

15. The substrate support assembly of claim 12 wherein the first set of zones is rotated at a forty five degree angle relative to the second set of zones.

16. The substrate support assembly of claim 12 wherein the first and second annular regions have different widths.

17. The substrate support assembly of claim 12 wherein the second annular zone has a different width than each of the first and second annular regions.

18. The substrate support assembly of claim 12 wherein each of the first and second sets of zones includes four zones.

19. A system comprising:

the substrate support assembly of claim 12; and

a controller configured to control one or more of the M resistive heaters based on a temperature sensed by one of the N temperature sensors and average temperatures of one or more of the M zones.

20. The system of claim 19 wherein the controller is configured to control one of the M resistive heaters independently of others of the M resistive heaters.

21. The system of claim 19 wherein the controller is configured to control one or more of the M resistive heaters based on a target temperature profile of the semiconductor substrate.

22. A system comprising:

the substrate support assembly of claim 12; and

a controller configured to control one or more of the M resistive heaters using a temperature sensed by one of the N temperature sensors in combination with open loop control of the M zones,

wherein the open loop control of the M zones includes correlating power supplied to each of the M zones to a measured temperature of the semiconductor substrate.

23. A system comprising:

the substrate support assembly of claim 12; and

a controller configured to control a first resistive heater of the M resistive heaters relative to a second resistive heater of the M resistive heaters based on a temperature sensed by one of the N temperature sensors and a ratio of resistances of the first and second resistive heaters.