What Is Claimed Is:

1. A heating assembly for heating a processing chamber, comprising:

a plurality of heating elements;

a cooling element having one or more cooling channels for receiving cooling fluid therein; and

a heat exchange device disposed between the plurality of heating elements and the cooling element, wherein the heat exchange device comprises a hot interface disposed adjacent to and in thermal contact with the plurality of heating elements and a cold interface disposed adjacent to and in thermal contact with the cooling element.

2. The heating assembly of claim 1, wherein the heat exchange device comprises one or more heat pipes, and each of the heat pipes comprises:

a thermal conductive shell forming a sealed chamber; and

a working fluid disposed in the sealed chamber, wherein the working fluid is at low pressure and configured to transfer heat by phase transition.

3. The heating assembly of claim 2, wherein the one or more heat pipes is integrated with the cooling element to form the one or more cooling channels for receiving the cooling fluid.

4. The heating assembly of claim 2, wherein the plurality of heating elements are closely arranged in a plane, and the one or more heat pipes laterally joined in the form of thin sheet surrounding each of the plurality of heating elements.

5. The heating assembly of claim 4, wherein the plurality of heating elements are grouped to form a plurality of heating zones.

6. The heating assembly of claim 4, wherein the plurality of heating elements are arranged in a hexagon packing.

7. The heating assembly of claim 2, wherein the cooling element forms one or more circles and the plurality of heating elements are evenly distributed along the one or more circles.

8. The heating assembly of claim 2, wherein the one or more heat pipes joined latterly to form of a thin sheet.

9. An apparatus for processing a substrate, comprising:

a chamber body forming a chamber enclosure;

a substrate support disposed in the chamber enclosure; and

a heating assembly of any one of claims 1-8 disposed outside the chamber enclosure and configured to direct thermal energy towards the chamber enclosure.

10. The apparatus of claim 9, wherein the chamber body comprises a quartz window, and the heating assembly is disposed outside the quartz window.

11. The apparatus of claim 10, further comprising a gas distribution showerhead distributed over the substrate support, and the quartz window is disposed below the substrate support.

12. The apparatus of claim 10, wherein the plurality of heat elements are one of ultra violet (UV) lamps, halogen lamps, laser diodes, resistive heaters, microwave powered heaters, or light emitting diodes (LEDs).

13. A method for processing a substrate, comprising:

directing radiant energy from a plurality of heating elements towards an enclose of a substrate processing chamber; and

cooling the plurality of heating elements using a heat exchange device disposed between the plurality of heating elements and a cooling element, wherein the heat exchange device comprises a hot interface disposed adjacent to and in

thermal contact with the plurality of heating elements and a cold interface disposed adjacent to and in thermal contact with the cooling element.

14. The method of claim 13, wherein the heat exchange device comprises one or more heat pipes, and each of the one or more heat pipes comprises:

a thermal conductive shell forming a sealed chamber; and

a working fluid disposed in the sealed chamber, wherein the working fluid is at low pressure and configured to transfer heat by phase transition.

15. The method of claim 14, wherein cooling the plurality of heating elements comprising flowing a cooling fluid through cooling channels formed in the cooling elements.

CLAIMS

1. A heating assembly for heating a processing chamber, comprising:

a plurality of heating elements;

a cooling element having one or more cooling channels for receiving cooling fluid therein; and

a heat exchange device disposed between the plurality of heating elements and the cooling element, wherein the heat exchange device comprises a hot interface disposed adjacent to and in thermal contact with the plurality of heating elements and a cold interface disposed adjacent to and in thermal contact with the cooling element, and the heat exchange device comprises one or more heat pipes, each heat pipe comprising:

a thermal conductive shell forming a sealed chamber; and

a working fluid disposed in the sealed chamber, wherein a first portion of the working fluid is in liquid phase and a second portion of the working liquid is in gas phase.

2. The heating assembly of claim 1, wherein the one or more heat pipes is integrated with the cooling element to form the one or more cooling channels for receiving the cooling fluid.

3. The heating assembly of claim 1, wherein the plurality of heating elements are closely arranged in a plane, and the one or more heat pipes are laterally joined in the form of thin sheet surrounding each of the plurality of heating elements.

4. The heating assembly of claim 3, wherein the plurality of heating elements are grouped to form a plurality of heating zones.

5. The heating assembly of claim 3, wherein the plurality of heating elements are arranged in a hexagon pattern.

6. The heating assembly of claim 1, wherein the cooling element forms one or more circles and the plurality of heating elements are evenly distributed along the one or more circles.

7. The heating assembly of claim 1, wherein the one or more heat pipes are joined latterly to form of a thin sheet.

8. An apparatus for processing a substrate, comprising:

a chamber body forming a chamber enclosure;

a substrate support disposed in the chamber enclosure; and

a heating assembly disposed outside the chamber enclosure and configured to direct thermal energy towards the chamber enclosure, wherein the heating assembly comprises:

a plurality of heating elements;

a cooling element having one or more cooling channels for receiving cooling fluid therein; and

a heat exchange device disposed between the plurality of heating elements and the cooling element, wherein the heat exchange device comprises a hot interface disposed adjacent to and in thermal contact with the plurality of heating elements and a cold interface disposed adjacent to and in thermal contact with the cooling element, and the heat exchange device comprises one or more heat pipes, each of the one or more heat pipes comprising:

a thermal conductive shell forming a sealed chamber; and

a working fluid disposed in the sealed chamber, wherein a first portion of the working fluid isin liquid phase and a second portion of the working liquid is in gas phase.

9. The apparatus of claim 8, wherein the chamber body comprises a quartz window, and the heating assembly is disposed outside the quartz window.

10. The apparatus of claim 9, further comprising a gas distribution showerhead distributed over the substrate support, and the quartz window is disposed below the substrate support.

11. The apparatus of claim 10, wherein the quartz window is shaped like a cone, and the cooling element of the heating assembly forms concentric circles and the plurality of heating elements are evenly distributed along the concentric circles.

12. The apparatus of claim 9, wherein the plurality of heating elements are closely arranged in a plane, and the one or more heat pipes are laterally joined to form a thin sheet surrounding each of the plurality of heating elements.

13. The apparatus of claim 12, wherein the plurality of heating elements are grouped in multiple heating zones.

14. The apparatus of claim 9, wherein the apparatus is one of a rapid thermal processing chamber, epitaxial deposition chamber, chemical vapor deposition chamber, physical vapor deposition chamber, or electron beam curing chamber.

15. The apparatus of claim 9, wherein the plurality of heat elements are one of ultra violet (UV) lamps, halogen lamps, laser diodes, resistive heaters, microwave powered heaters, or light emitting diodes (LEDs).

16. A method for processing a substrate, comprising:

directing radiant energy from a plurality of heating elements towards an enclose of a substrate processing chamber; and

cooling the plurality of heating elements using a heat exchange device disposed between the plurality of heating elements and a cooling element, wherein the heat exchange device comprises a hot interface disposed adjacent to and in thermal contact with the plurality of heating elements and a cold interface disposed adjacent to and in thermal contact with the cooling element, and the heat exchange device comprises one or more heat pipes, each of the one or more heat pipes comprising:

a thermal conductive shell forming a sealed chamber; and

a working fluid disposed in the sealed chamber, wherein a first portion of the working fluid is in liquid phase and a second portion of the working liquid is in gas phase.

17. The method of claim 16, wherein cooling the plurality of heating elements comprises flowing a cooling fluid through cooling channels formed in the cooling elements.

18. The heating assembly of claim 1, wherein each of the one or more heat pipes further comprises a wick structure lined inside the thermal conductive shell.

19. The heating assembly of claim 1, wherein the heat exchange device comprises a plurality of parallel and independently operating heat pipes.

20. The apparatus of claim 8, wherein each of the one or more heat pipes further comprises a wick structure lined inside the thermal conductive shell.