CLAIMS

1. An electric heater apparatus for use in processing a semiconductor wafer in a wafer processing chamber, comprising:

a first thermally conductive layer comprising an electrically insulating material, a top side, and a bottom side;

one or more electrically conductive heating elements disposed in respective ones of one or more grooves arranged on the top side of the first thermally conductive layer, the one or more electrically conductive heating elements comprising one or more refractory hard metals doped with at least one of carbon, nitrogen, aluminum, yttrium, or oxygen, the doped one or more refractory hard metals comprising a temperature insensitive electrical resistance over temperatures ranging from 300˚C to 850˚C, wherein the one or more electrically conductive heating elements are independently controllable to provide one or more heating zones along the top side of the first thermally conductive layer; and

a second thermally conductive layer disposed on the top side of the first thermally conductive layer over the one or more electrically conductive heating elements.

2. The electric heater apparatus of Claim 1, wherein the first thermally conductive layer comprises a disc.

3. The electric heater apparatus of Claim 1, wherein the first thermally conductive layer is sintered, and wherein the one or more electrically conductive heating elements initially comprise one of a powder, a paint, and a pre-cut pattern from a polymer sheet prior to sintering the first thermally conductive layer.

4. The electric heater apparatus of Claim 1, wherein a concentration of carbon is allowed to vary from 0.1 at% to 50 at%, a concentration of aluminum is allowed to vary from 0.1 at% to 20 at%, a concentration of nitrogen is allowed to vary from 0 at% to 20 at%, a concentration of oxygen is allowed to vary from 0 at% to 5 at%, and a concentration of yttrium is allowed to vary from 0 at% to 3 at%.

5. The electric heater apparatus of Claim 1, wherein the first thermally conducting layer comprises aluminum nitride.

6. The electric heater apparatus of Claim 1, including a third thermally conductive layer disposed on the bottom side of the first thermally conductive layer, the third thermally conductive layer comprising a hub.

7. The electric heater apparatus of Claim 6, wherein the second and third thermally conductive layers comprise aluminum nitride.

8. The electric heater apparatus of Claim 6, including a sintered riser affixed to the hub.

9. The electric heater apparatus of Claim 6, including a sintered riser bonded to the hub, and the sintered riser bonded to the hub creates a helium tight seal with the hub.

10. The electric heater apparatus of Claim 6, including one or more electrical interconnects disposed in respective ones of one or more channels arranged on the bottom side of the first thermally conductive layer.

11. The electric heater apparatus of Claim 10, wherein the electrical interconnects are configured to communicate electricity in a circuit from the hub to the one or more electrically conductive heating elements and from the one or more electrically conductive heating elements to the hub.

12. The electric heater apparatus of Claim 10, wherein the electrical interconnects are configured to communicate sensor data from one or more temperature sensors to the hub.

13. The electric heater apparatus of Claim 12, wherein the one or more temperature sensors are disposed in respective ones of one or more channels arranged on the bottom side of the first thermally conductive layer and under the third thermally conductive layer.

14. The electric heater apparatus of Claim 13, wherein the third thermally conductive layer is disposed over the one or more temperature sensors.

15. The electric heater apparatus of Claim 1, wherein the one or more electrically conductive heating elements and the first thermally conductive layer comprise a functionally similar coefficient of thermal expansion to avoid deleterious cracks or fissures in the electric heater apparatus.

16. An electric heater apparatus for use in processing a semiconductor wafer in a wafer processing chamber, comprising:

a sintered disc comprising a thermally conductive and electrically insulating material, a top side, and a bottom side;

one or more electrically conductive heating elements disposed in respective ones of one or more grooves arranged on the top side of the disc, the one or more electrically conductive heating elements comprising one or more refractory hard

metals doped with at least one of carbon, nitrogen, aluminum, yttrium, or oxygen, the doped one or more refractory hard metals comprising a temperature insensitive electrical resistance over temperatures ranging from 300˚C to 850˚C, wherein the one or more electrically conductive heating elements are independently controllable to provide one or more heating zones along the top side of the disc;

a first thermally conductive layer disposed on the top side of the disc over the one or more electrically conductive heating elements;

one or more interconnects disposed in respective ones of one or more channels arranged on the bottom side of the disc; and

a second thermally conductive layer disposed on the bottom side of the disc over the one or more interconnects, the second thermally conductive layer comprising a hub,

wherein the one or more electrically conductive heating elements are protected from chemical attack.

17. The electric heater apparatus of Claim 16, wherein a concentration of carbon is allowed to vary from 0.1 at% to 50 at%, a concentration of aluminum is allowed to vary from 0.1 at% to 20 at%, a concentration of nitrogen is allowed to vary from 0 at% to 20 at%, and a concentration of oxygen is allowed to vary from 0 at% to 5 at%, and a concentration of yttrium is allowed to vary from 0 at% to 3 at%.

18. The electric heater apparatus of Claim 16, wherein the thermally conducting and electrically insulating material is aluminum nitride.

19. The electric heater apparatus of Claim 16, wherein the first and second thermally conductive layers comprise aluminum nitride.

20. The electric heater apparatus of Claim 16, including a riser affixed to the hub.

21. The electric heater apparatus of Claim 20, wherein the riser is bonded to the hub, and the riser bonded to the hub creates a helium tight seal with the hub.

22. The electric heater apparatus of Claim 16, wherein the interconnects includes one or more electrical interconnects, and the electrical interconnects are configured to communicate electricity in a circuit from the hub to the one or more electrically conductive heating elements and from the one or more electrically conductive heating elements to the hub.

23. The electric heater apparatus of Claim 16, including one or more temperature sensors disposed in the one or more channels.

24. The electric heater apparatus of Claim 23, wherein the second thermally conductive layer is disposed over the one or more temperature sensors.

25. The electric heater apparatus of Claim 16, wherein the one or more electrically conductive heating elements and the disc comprise a functionally similar coefficient of thermal expansion to avoid deleterious cracks or fissures in the electric heater apparatus.

26. The electric heater apparatus of Claim 16, wherein the one or more electrically conductive heating elements are independently controllable to provide one or more heating zones along the top side of the disc.

27. A method of manufacturing an electric heater apparatus for use in processing a semiconductor wafer in a wafer processing chamber, comprising:

preparing a disc comprising aluminum nitride powder comprising a sintering aid comprising yttria from 3 to 5 wt% of the aluminum nitride powder, a top side, and a bottom side;

fabricating one or more grooves on the top side of the disc;

depositing one or more electrically conductive heating elements in respective ones of one or more grooves arranged on the top side of the disc, the one or more electrically conductive heating elements comprising one or more refractory hard metals doped with at least one of carbon, nitrogen, aluminum, yttrium, or oxygen, the doped one or more refractory hard metals comprising a temperature insensitive electrical resistance over temperatures ranging from 300˚C to 850˚C, wherein the one or more electrically conductive heating elements are independently controllable to provide one or more heating zones along the top side of the disc;

depositing a first powder comprising aluminum nitride on the top side of the disc over the one or more electrically conductive heating elements;

pressing the disc in a die at least once to consolidate the first powder;

fabricating one or more channels on the bottom side of the disc;

depositing one or more electrically conductive interconnects in the one or more channels on the bottom side of the disc;

depositing a second powder comprising aluminum nitride on the bottom side of the disc over the one or more electrically conductive interconnects;

pressing the disc in a die at least once to consolidate the second powder;

machining and grinding the pressed disc with the deposited first and second powders to include a hub, the pressed and machined disc with the deposited first and second powders defining an aluminum nitride matrix having embedded heating elements and interconnects;

sintering the aluminum nitride matrix at temperatures ranging from 1600˚C to 1850˚C, wherein the step of sintering is performed in a nitrogen environment under controlled heating to burn off any temporary binders in the aluminum nitride matrix, wherein an amount of carbon is maintained below an oxygen content of aluminum nitride in the aluminum nitride matrix that is not associated with yttria so that a composition of a liquid phase of alumina and yttria is such that Al_2O_3/Y_2O_3 molar ratio in the sintered aluminum nitride matrix is 10:3 to 0.1:1, wherein a portion of the amount of carbon is incorporated in the doped one or more refractory hard metals of the one or more electrically conductive heating elements, wherein sintering forms a densified aluminum nitride matrix including densified one or more electrically conductive heating elements within the sintered aluminum nitride matrix; and

bonding a sintered riser to the hub.