carrier network discussed above, or it may be a general purpose computer selectively activated or configured by a computer program stored in the computer. In particular, various general purpose machines may be used with computer programs written in accordance with the teachings herein, or it may be more convenient to construct a more specialized apparatus to perform the required operations.

[0075] The invention can also be embodied as computer readable code on a computer readable medium. The computer readable medium is any data storage device that can store data, which can thereafter be read by a computer system. Examples of the computer readable medium include hard drives, network attached storage (NAS), read-only memory, random-access memory, CD-ROMs, CD-Rs, CD-RWs, DVDs, Flash, magnetic tapes, and other optical and non-optical data storage devices. The computer readable medium can also be distributed over a network coupled computer systems so that the computer readable code is stored and executed in a distributed fashion.

[0076] Although the foregoing example embodiments have been described in some detail for purposes of clarity of understanding, it will be apparent that certain changes and modifications may be practiced within the scope of the appended claims. For example, the electrostatic chuck might be tripolar (e.g., a polar region might be associated with a magnitude in addition to being positive or negative) rather than bipolar or unipolar, in an alternative example embodiment. Accordingly, the example embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalents of the appended claims.

~~*What is claimed is:*~~

Claims:

1. An apparatus for electrostatic chucking and dechucking, comprising:

an electrostatic chuck with a plurality of zones and a plurality of lift pins, wherein each zone includes one or more polar regions which are electrically polar around one of said lift pins for contacting a bottom surface of a substrate, wherein the lift pin is associated one-to-one with a sensor;

one or more lift-pin controllers that control the lift pins;

one or more polar-region controllers that control the polar regions; and

a process controller that includes an application program that controls the one or more lift-pin controllers and the one or more polar-region controllers in order to make variations from zone to zone based on sensor measurements, wherein the variations include one or both of applied voltage to the polar regions or upward force of the lift pins.

2. An apparatus as in claim 1, wherein the lift pin further comprises a pneumatic cylinder.

3. An apparatus as in claim 1, wherein the sensor provides feedback to the one or more lift-pin controllers.

4. An apparatus as in claim 1, wherein one polar-region controller is connected to all the polar regions.

5. An apparatus as in claim 4, wherein the sensor provides feedback to the polar-region controller.

6. An apparatus as in claim 1, wherein a separate polar-region controller is connected to each polar region.

7. An apparatus as in claim 6, wherein the sensor provides feedback to each polar-region controller.

8. An apparatus as in claim 1, further comprising a sensor pin.

9. An apparatus as in claim 8, wherein the sensor pin provides feedback to the one or more lift-pin controllers.

10. An apparatus as in claim 9, wherein one polar-region controller is connected to all polar regions.

11. An apparatus as in claim 10, wherein the sensor pin provides feedback to the polar-region controller.

12. An apparatus as in claim 9, wherein a separate polar-region controller is connected to each polar region.

13. An apparatus as in claim 12, wherein the sensor pin provides feedback to each polar-region controller.

14. A chamber for processing a semiconductor wafer, the chamber comprising:

an electrostatic chuck defined to support a substrate, the electrostatic chuck having a plurality of bores for receiving a plurality of lift pins for engaging the substrate when present, wherein each of the lift pins is associated one-to-one with a sensor, the electrostatic chuck including a plurality of polar regions that are electrically polar and that are defined to at least partially surround each of the plurality of bores, and

a process controller that includes an application program that controls the one or more lift-pin controllers that control the lift pins and the one or more polar-region controllers that control the polar regions in order to make variations from zone to zone based on sensor measurements, wherein the variations include one or both of applied voltage to the polar regions or upward force of the lift pins.

15. The chamber of claim 14, wherein each of the plurality of polar regions has a geometric pattern and a voltage supply coupled to the geometric pattern.

16. The chamber of claim 14, wherein each of the plurality of polar regions is coupled to a same voltage.

17. The chamber of claim 14, wherein each of the plurality of polar regions is coupled to a different voltage.

18. The chamber of claim 14, wherein each of the plurality of polar regions defines a zone, and each zone is coupled to a voltage supply.

19. The chamber of claim 14, wherein the electrostatic chuck includes,

a metallic base;

a dielectric layer disposed over the metallic base, the dielectric layer defining a surface for the support of the substrate;

the geometric patterns defined from a conductive metal disposed in the dielectric layer; and

circuitry for applying voltage to the conductive material, wherein the circuitry is disposed in the dielectric layer.

20. The chamber of claim 19, wherein the bores are defined through the metallic base and the dielectric layer.

Claims

1. An apparatus for electrostatic chucking and dechucking, comprising:

an electrostatic chuck with a plurality of zones, wherein each zone includes one or more polar regions around a lift pin for contacting a bottom surface of a substrate;

one or more controllers that control the lift pins; and

one or more controllers that control the polar regions.

2. An apparatus as in claim 1, wherein the lift pin further comprises a pneumatic cylinder.

3. An apparatus as in claim 2, wherein each lift pin is associated with a separate sensor.

4. An apparatus as in claim 3, wherein the sensor provides feedback to the controller for the lift pin.

5. An apparatus as in claim 4, wherein one controller is connected to all lift pins.

6. An apparatus as in claim 4, wherein a separate controller is connected to each lift pin.

7. An apparatus as in claim 6, wherein the sensor provides feedback to the controller for the lift pin.

8. An apparatus as in claim 3, wherein one controller is connected to all the polar regions.

9. An apparatus as in claim 8, wherein the sensor provides feedback to the controller for the polar regions.

10. An apparatus as in claim 3, wherein a separate controller is connected to each polar region.

11. An apparatus as in claim 10, wherein the sensor provides feedback to each controller for each polar region.

12. An apparatus as in claim 1, further comprising a sensor pin.

13. An apparatus as in claim 12, wherein the sensor pin provides feedback to the controller for the lift pin.

14. An apparatus as in claim 13, wherein one controller is connected to all polar regions.

15. An apparatus as in claim 14, wherein the sensor pin provides feedback to the controller for the polar regions.

16. An apparatus as in claim 13, wherein a separate controller is connected to each polar region.

17. An apparatus as in claim 16, wherein the sensor pin provides feedback to each controller for each polar region.

18. An automated method for processing a substrate for manufacturing integrated circuits, comprising operations of:

placing the substrate on an electrostatic chuck in a process chamber, wherein the electrostatic chuck includes a plurality of zones and wherein each zone includes one or more polar regions around a lift pin moved by pneumatic pressure;

clamping the substrate to the electrostatic chuck by applying a voltage to the one or more polar regions;

processing the substrate;

terminating the processing operation;

applying another voltage to the one or more polar regions of the one or more zones to initiate dechucking;

causing one or more lift pins to come into contact with a bottom surface of the substrate; and

measuring, with a sensor, an electrostatic force between the substrate and the electrostatic chuck.

19. The method of claim 18, further comprising the operation of adjusting the pneumatic pressure of one or more lift pins.

20. The method of claim 18, further comprising the operation of adjusting the voltage of one or more polar regions in one or more zones.

21. The method of claim 18, wherein the operation of processing the substrate includes generating a plasma and using the plasma to etch the substrate, deposit a material on the substrate, or perform another semiconductor manufacturing operation.

22. A chamber for processing a semiconductor wafer, the chamber comprising:

an electrostatic chuck defined to support a substrate, the electrostatic chuck having a plurality of bores for receiving lift pins for engaging the substrate when present, the electrostatic chuck including a plurality of polar regions that are defined to at least partially surround each of the plurality of bores.

23. The chamber of claim 22, wherein each of the plurality of polar regions has a geometric pattern and a voltage supply coupled to the geometric pattern.

24. The chamber of claim 22, wherein each of the plurality of polar regions is coupled to a same voltage.

25. The chamber of claim 22, wherein each of the plurality of polar regions is coupled to a different voltage.

26. The chamber of claim 22, wherein each of the plurality of polar regions defines a zone, and each zone is coupled to a voltage supply.

27. The chamber of claim 22, wherein the electrostatic chuck includes,

a metallic base;

a dielectric layer disposed over the metallic base, the dielectric layer defining a surface for the support of the substrate;

the geometric patterns defined from a conductive metal disposed in the dielectric layer; and

circuitry for applying voltage to the conductive material, wherein the circuitry is disposed in the dielectric layer.

28. The chamber of claim 27, wherein the bores are defined through the metallic base and the dielectric layer.