

## CLAIMS

What is claimed is:

1. A moveable edge ring system for a substrate processing system, comprising:
  - 5 a top moveable ring including a first annular body arranged around a substrate support, wherein the top moveable ring comprises conductive material and is exposed to plasma during substrate processing;
  - a moveable support ring arranged below the top moveable ring and radially outside of a baseplate of the substrate support and including a second annular body; and
  - 10 a shield ring arranged radially outside of the moveable support ring and including a third annular body;
  - a cover ring including a fourth annular body arranged above a radially outer edge of the top moveable ring; and
  - an actuator and a lift pin configured to adjust a position of the top moveable ring
  - 15 and the moveable support ring relative to the shield ring and the cover ring.
2. The moveable edge ring system of claim 1, wherein the top moveable ring includes a first annular recess on an upper and radially outer surface of the first annular body.
- 20 3. The moveable edge ring system of claim 2, wherein:
  - the shield ring includes a projection extending upwardly from an upper and radially outer surface of the third annular body; and
  - the cover ring includes:
    - a second annular recess configured to receive the projection; and
    - 25 a third annular recess configured to align with the first annular recess of the top moveable ring when the top moveable ring and the moveable support ring are raised.
4. The moveable edge ring system of claim 1, wherein the top moveable ring, the moveable support ring and the shield ring are conductive, and the cover ring is
- 30 nonconductive.

5. The moveable edge ring system of claim 4, wherein as the top moveable ring and the moveable support ring are moved from a lowest position to intermediate positions and to an uppermost position, the moveable support ring maintains:

greater than or equal to 70% of vertical side portions of a radially outer surface of

5 the moveable support ring within a predetermined coupling gap of the shield ring; and

greater than or equal to 50% of vertical side portions of a radially inner surface of the moveable support ring are located within a predetermined coupling gap of the baseplate,

10 wherein the predetermined coupling gap is greater than zero and less than or equal to 20 mils.

6. The moveable edge ring system of claim 4, wherein as the top moveable ring and the moveable support ring are moved from a lowest position to intermediate positions and to an uppermost position, the moveable support ring maintains:

15 greater than or equal to 90% of vertical side portions of a radially outer surface of the moveable support ring within a predetermined coupling gap of the shield ring; and

greater than or equal to 60% of vertical side portions of a radially inner surface of the moveable support ring are located within a predetermined coupling gap of the baseplate,

20 wherein the predetermined coupling gap is greater than zero and less than or equal to 20 mils.

7. The moveable edge ring system of claim 1, further comprising an edge ring including a fifth annular body having an "L"-shaped cross-section, wherein the substrate support includes a heating layer arranged on a baseplate, and wherein the edge ring is arranged between the heating layer of the substrate support and radially inner sides of the top moveable ring and the moveable support ring.

8. The moveable edge ring system of claim 7, wherein the top moveable ring, the moveable support ring and the shield ring are conductive, and the cover ring and the edge ring are nonconductive.

9. The moveable edge ring system of claim 1, further comprising an edge ring including a fifth annular body and arranged radially outside of the shield ring and the

cover ring, wherein the top moveable ring, the moveable support ring and the shield ring are conductive and the cover ring and the edge ring are nonconductive.

10. The moveable edge ring system of claim 9, wherein the edge ring includes an annular recess on an upper and radially inner surface thereof to receive the cover ring.

11. The moveable edge ring system of claim 1, wherein a lower surface of the moveable support ring includes a ring centering portion to center the moveable support ring when the lift pin biases the ring centering portion.

12. The moveable edge ring system of claim 1, wherein a lower surface of the top moveable ring includes a ring centering portion to center the top moveable ring when the moveable support ring biases the ring centering portion of the top moveable ring.

13. The moveable edge ring system of claim 1, wherein at least one of the top moveable ring, the moveable support ring and the shield ring includes a horizontal ring spacer.

14. The moveable edge ring system of claim 13, wherein the horizontal ring spacer includes at least one of a shim, a projection and a pin.

15. A system comprising:  
the moveable edge ring system of claim 1;  
the substrate support configured to support a substrate; and  
a controller configured to control the actuator to move the lift pin to adjust a height of the moveable support ring and the top moveable ring relative to the substrate support.

16. The system of claim 15, wherein the controller is configured to adjust the height of the moveable support ring and the top moveable ring in response to at least one of a number of RF plasma cycles, a number of substrates processed and a period of a RF exposure.

~~17. An edge ring system for a substrate processing system, comprising:~~

— a top stationary ring including a first annular body that is directly exposed to plasma during substrate processing;

— a moveable ring arranged below the top stationary ring and radially outside of a baseplate of a substrate support and including a second annular body;

5 — a shield ring arranged below and radially outside of the moveable ring and including a third annular body; and

— an actuator and lift pin configured to adjust a position of the moveable ring relative to the top stationary ring and the shield ring.

10 18. The edge ring system of claim 17, further comprising a cover ring that is nonconductive and that is arranged above a radially outer edge of the top stationary ring.

19. The edge ring system of claim 18, wherein the top stationary ring includes a first annular recess on an upper and radially outer surface of the first annular body.

15 20. The edge ring system of claim 19, wherein:

— the shield ring includes a projection extending upwardly from an upper and radially outer surface of the third annular body; and

— the cover ring includes:

20 — a second annular recess configured to receive the projection; and

— a third annular recess configured to mate with the first annular recess of the top stationary ring.

25 21. The edge ring system of claim 17, wherein the top stationary ring, the moveable ring and the shield ring are made of conductive material.

22. The edge ring system of claim 21, wherein as the moveable ring is moved from a lowest position to intermediate positions and to an uppermost position, the moveable ring maintains:

30 — greater than or equal to 70% of vertical side portions of a radially outer surface of the moveable ring within a predetermined coupling gap of the shield ring; and

— greater than or equal to 50% of vertical side portions of a radially inner surface of the moveable ring within a predetermined coupling gap of the baseplate;

— wherein the predetermined coupling gap is less than or equal to 30 mils.

23. The edge ring system of claim 21, wherein the moveable ring has a “T” shaped cross-section and the shield ring has an inverted “T” shaped cross-section.

24. The edge ring system of claim 17, further comprising a cover ring including a fourth annular body, wherein a substrate support includes a heating layer arranged on a baseplate, and wherein the cover ring is arranged between the heating layer of the substrate support and a radially inner surface of the top stationary ring when the top stationary ring is in a lowered position.

25. The edge ring system of claim 24, wherein the top stationary ring, the moveable ring and the shield ring are conductive, and the cover ring is nonconductive.

26. The edge ring system of claim 20, further comprising an edge ring including an annular body and arranged radially outside of the shield ring.

27. The edge ring system of claim 26, wherein the edge ring includes an annular recess on an upper and radially inner surface thereof to receive the cover ring, wherein the top stationary ring, the moveable ring and the shield ring are conductive and the cover ring and the edge ring are nonconductive.

28. The edge ring system of claim 17, wherein the top stationary ring includes a radially inner portion, an upwardly sloped portion extending from the radially inner portion, a planar portion extending from the upwardly sloped portion.

29. The edge ring system of claim 28, wherein the moveable ring includes a radially inwardly projecting portion and a radially outwardly projecting portion, and wherein an upper and radially inner surface of the radially inwardly projecting portion includes a sloped portion.

30. The edge ring system of claim 29, wherein an upper surface of the sloped portion extends parallel to a lower surface of the upwardly sloped portion.

31. The edge ring system of claim 17, wherein a lower surface of the moveable ring includes a ring centering portion to center the moveable ring when the lift pin biases the ring centering portion of the moveable ring.

5 32. The edge ring system of claim 17, wherein at least one of the top stationary ring, the moveable ring and the shield ring includes a horizontal ring spacer.

33. The edge ring system of claim 32, wherein the horizontal ring spacer includes at least one of a shim, a projection and a pin.

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34. A system comprising:

the edge ring system of claim 17;

the substrate support configured to support a substrate; and

a controller configured to adjust a height of the actuator to move the lift pin to  
15 adjust a height of the moveable ring relative to the top stationary ring.

35. The system of claim 34, wherein the controller is configured to adjust the height of the moveable ring in response to at least one of a number of RF plasma cycles, a number of substrates processed and a period of a RF exposure.

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36. A substrate processing system, comprising:

a substrate support including cylindrical body, an annular projecting portion extending from a lower portion of the cylindrical body, and a shield portion extending upwardly from a radially outer edge of the annular projecting portion, wherein a cavity is defined between the cylindrical body and the shield portion;

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a top moveable ring including a first annular body arranged around a substrate support, wherein the top moveable ring is exposed to plasma during substrate processing; and

a moveable support ring including a second annular body, wherein the moveable support ring is arranged below the top moveable ring in the cavity between the shield portion and the cylindrical body.

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37. The substrate processing system of claim 36, further comprising:

a cover ring arranged above a radially outer edge of the top moveable ring; and

~~an actuator and lift pin configured to adjust a position of the top moveable ring and the moveable support ring relative to the shield portion and the cover ring.~~

38. ~~The substrate processing system of claim 37, wherein the top moveable ring includes a first annular recess on an upper and radially outer surface of the first annular body.~~

39. ~~The substrate processing system of claim 37, wherein the top moveable ring, the cylindrical body, the moveable support ring and the shield portion are conductive, and the cover ring is nonconductive.~~

40. ~~The substrate processing system of claim 39, wherein as the top moveable ring and the moveable support ring are moved from a lowest position to intermediate positions and to an uppermost position, the moveable support ring maintains:~~

~~greater than or equal to 70% of vertical side portions of a radially inner surface of the moveable support ring within a predetermined coupling gap of the cylindrical body; and~~

~~greater than or equal to 50% of vertical side portions of a radially outer surface of the moveable support ring are located within a predetermined coupling gap of the shield portion,~~

~~wherein the predetermined coupling gap is greater than zero and less than or equal to 20 mils.~~

41. ~~The substrate processing system of claim 37, wherein a lower surface of the moveable support ring includes a ring centering portion to center the moveable support ring relative to the cylindrical body when the lift pin biases the ring centering portion of the moveable support ring.~~

42. ~~The substrate processing system of claim 36, wherein at least one of the top moveable ring, the moveable support ring and the shield ring includes a horizontal ring spacer.~~

43. ~~The substrate processing system of claim 42, wherein the horizontal ring spacer includes at least one of a shim, a projection and a pin.~~

44. The substrate processing system of claim 42, further comprising:

an actuator;

a lift pin; and

5 a controller configured to cause the actuator to move the lift pin to adjust a height of the moveable support ring and the top moveable ring relative to the substrate support.

45. The substrate processing system of claim 44, wherein the controller is configured to adjust the height of the moveable support ring and the top moveable ring in response to at least one of a number of RF plasma cycles, a number of substrates processed and a period of a RF exposure.

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46. A moveable edge ring system for a substrate processing system, comprising:  
a top moveable ring including a first annular body arranged around a substrate support, wherein an upper surface of the top moveable ring is exposed to plasma during substrate processing;

5 a moveable support ring arranged below the top moveable ring and radially outside of a baseplate of the substrate support and including a second annular body; and  
a shield ring arranged below and radially outside of the moveable support ring and including a third annular body; and

10 an actuator and lift pin configured to adjust a position of the top moveable ring and the moveable support ring relative to the shield ring;

wherein the top moveable ring, the moveable support ring and the shield ring are made of conductive material, and

15 wherein as the top moveable ring and the moveable support ring are moved from a lowest position to intermediate positions and to an uppermost position, the moveable support ring maintains:

greater than or equal to 70% of vertical side portions of a radially outer surface of the moveable support ring within a predetermined coupling gap of the shield ring; and

20 greater than or equal to 50% of vertical side portions of a radially inner surface of the moveable support ring within a predetermined coupling gap of the baseplate;

wherein the predetermined coupling gap is greater than zero and less than or equal to 20 mils.

25 47. The moveable edge ring system of claim 46, wherein the predetermined coupling gap is greater than zero and less than or equal to 10 mils.