

CLAIMS

1. An edge ring assembly for a plasma processing chamber, comprising:
5 an edge ring configured to surround an electrostatic chuck (ESC) that is configured for electrical connection to a first RF power supply, the ESC having a top surface for supporting a substrate and an annular step surrounding the top surface, the annular step defining an annular shelf that is lower than the top surface;
an annular electrode disposed below the edge ring and above the annular shelf,
10 such that a first portion of the annular electrode is disposed below the substrate, when present on the top surface of the ESC, to define a radial overlap between the annular electrode and a periphery of the edge ring and a second portion of the annular electrode extends radially beyond a diameter of the substrate;
a dielectric ring disposed below the annular electrode for isolating the annular
15 electrode from the ESC, the dielectric ring positioned over the annular shelf; and
a plurality of insulated connectors disposed through the ESC and through the dielectric ring, each of the plurality of insulated connectors providing electrical connection between a second RF power supply and the annular electrode.
- 20 2. The edge ring assembly of claim 1, wherein each of the plurality of insulated connectors is defined by a coaxial connector.
3. The edge ring assembly of claim 1, wherein the plurality of insulated
connectors are configured to isolate the second RF power supply from the first RF
25 power supply.

4. The edge ring assembly of claim 1, wherein the edge ring has a top surface, the top surface of the edge ring having a stepped edge defined at an inner diameter of the edge ring, a lower portion of the stepped edge is configured to sit at a lower height than the top surface of the ESC, such that the substrate when present
5 extends over the lower portion of the stepped edge.

5. The edge ring assembly of claim 4, wherein at least a portion of the annular electrode is disposed below the stepped edge of the edge ring.

10 6. The edge ring assembly of claim 1, wherein application of RF power to the annular electrode during plasma processing causes a plasma sheath that is defined during the plasma processing to be radially extended in a spatial region that is defined substantially over the edge ring.

15 7. The edge ring assembly of claim 6, wherein the application of RF power to the annular electrode during plasma processing reduces ion focusing at an edge region of the substrate.

8. The edge ring assembly of claim 7, wherein the application of RF
20 power to the annular electrode during plasma processing reduces tilting of ion trajectories at the edge region of the substrate away from normal to a top surface of the substrate.

9. The edge ring assembly of claim 1, wherein the annular electrode
25 has a radial width of about 5 to 28 millimeters.

10. The edge ring assembly of claim 1, wherein the annular electrode has a thickness of about 0.5mm to 5 millimeters.

11. The edge ring assembly of claim 1, wherein the annular electrode is defined by a plurality of concentric electrodes, each of the plurality of concentric electrodes being electrically connected to the second RF power supply.

12. The edge ring assembly of claim 1, wherein the annular electrode is defined by a mesh-like structure of a conductive material.

13. The edge ring assembly of claim 1, wherein the annular electrode is integrated with the edge ring.

14. The edge ring assembly of claim 1, wherein the annular electrode has a radial width that is at least as wide as a radial width of the edge ring.

15. An edge ring assembly for a plasma processing chamber, comprising:
an edge ring configured to surround an electrostatic chuck (ESC) that is configured for electrical connection to a first RF power supply, the ESC having a top surface for supporting a substrate and an annular step surrounding the top surface, the annular step defining an annular shelf that is lower than the top surface;

an annular electrode disposed below the edge ring and above the annular shelf, such that a first portion of the annular electrode is disposed below a substrate, when present on the top surface of the ESC, to define a radial overlap between the annular electrode and a periphery of the edge ring and a second portion of the annular electrode extends radially beyond a diameter of the substrate;

a dielectric ring disposed below the annular electrode for isolating the annular electrode from the ESC, the dielectric ring positioned over the annular shelf; and

a plurality of insulated connectors disposed through the dielectric ring, each of the plurality of insulated connectors providing electrical connection between a second
5 RF power supply and the annular electrode.

16. The edge ring assembly of claim 15, wherein each of the plurality of insulated connectors is defined by a coaxial connector.

10 17. The edge ring assembly of claim 15, wherein the plurality of insulated connectors are configured to isolate the second RF power supply from the first RF power supply.

15 18. The edge ring assembly of claim 15, wherein the edge ring has a top surface, the top surface of the edge ring having a stepped edge defined at an inner diameter of the edge ring, a lower portion of the stepped edge is configured to sit at a lower height than the top surface of the ESC, such that the substrate when present extends over the lower portion of the stepped edge.

20 19. The edge ring assembly of claim 18, wherein at least a portion of the annular electrode is disposed below the stepped edge of the edge ring.

20. The edge ring assembly of claim 15, wherein application of RF power to the annular electrode during plasma processing causes a plasma sheath that is
25 defined during the plasma processing to be radially extended in a spatial region that is defined substantially over the edge ring.

21. The edge ring assembly of claim 20, wherein the application of RF power to the annular electrode during plasma processing reduces ion focusing at an edge region of the substrate.

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22. The edge ring assembly of claim 21, wherein the application of RF power to the annular electrode during plasma processing reduces tilting of ion trajectories at the edge region of the substrate away from normal to a top surface of the substrate.

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23. An edge ring assembly for a plasma processing chamber, comprising:
an edge ring configured to surround an electrostatic chuck (ESC) that is configured for electrical connection to a first RF power supply, the ESC having a top surface for supporting a substrate and an annular step surrounding the top surface, the
15 annular step defining an annular shelf that is lower than the top surface;

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an annular electrode disposed below the edge ring and above the annular shelf, such that a first portion of the annular electrode is disposed below the substrate, when present on the top surface of the ESC, to define a radial overlap between the annular electrode and a periphery of the edge ring and a second portion of the annular
20 electrode extends radially beyond a diameter of the substrate, the annular electrode configured for electrical connection to a second RF power supply;

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a dielectric ring disposed below the annular electrode for isolating the annular electrode from the ESC, the dielectric ring positioned over the annular shelf.

24. The edge ring assembly of claim 23, further comprising at least one insulated connector that connects the annular electrode to the second RF power supply.

5 25. The edge ring assembly of claim 24, wherein the at least one insulated connector is configured to isolate the second RF power supply from the first RF power supply.

10 26. The edge ring assembly of claim 23, wherein the edge ring has a top surface, the top surface of the edge ring having a stepped edge defined at an inner diameter of the edge ring, a lower portion of the stepped edge is configured to sit at a lower height than the top surface of the ESC, such that the substrate when present extends over the lower portion of the stepped edge.

15 27. The edge ring assembly of claim 26, wherein at least a portion of the annular electrode is disposed below the stepped edge of the edge ring.

28. The edge ring assembly of claim 23, wherein application of RF power to the annular electrode during plasma processing causes a plasma sheath that is
20 defined during the plasma processing to be radially extended in a spatial region that is defined substantially over the edge ring.

29. The edge ring assembly of claim 28, wherein the application of RF power to the annular electrode during plasma processing reduces ion focusing at an
25 edge region of the substrate.

30. The edge ring assembly of claim 29, wherein the application of RF power to the annular electrode during plasma processing reduces tilting of ion trajectories at the edge region of the substrate away from normal to a top surface of the substrate.