

CLAIMS

1. In a plasma processing chamber, a method for processing a substrate comprising:

supporting said substrate in said plasma processing chamber configured with an upper electrode and a lower electrode;
configuring at least one radio frequency (RF) power source to ignite plasma between said upper electrode and said lower electrode;
providing a conductive coupling ring, said conductive coupling ring is coupled to said lower electrode to provide a conductive path;
providing a plasma-facing-substrate-periphery (PFSP) ring, said PFSP ring being disposed above said conductive coupling ring; and
coupling said PFSP ring to at least one of
a direct current (DC) ground through an RF filter,
said DC ground through said RF filter and a variable resistor,
a positive DC power source through said RF filter, and
a negative DC power source through said RF filter
to control plasma processing parameters.

2. The method of claim 1, wherein said PFSP ring is a hot edge ring.

3. The method of claim 1, wherein said PFSP ring is different from a hot edge ring, said PFSP ring can be any type of plasma-facing ring on the periphery of said substrate.

4. The method of claim 1, wherein said conductive coupling ring is made of Aluminum.

5. The method of claim 1, wherein said PFSP ring is made of silicon.

6. The method of claim 1, wherein said RF power source has an RF frequency of about 2 MHz.

7. The method of claim 1, wherein said RF power source has an RF frequency of about 27 MHz.

8. The method of claim 1, wherein said RF power source has an RF frequency of about 60 MHz.

9. The method of claim 1, wherein said plasma processing system is a capacitively-coupled plasma processing system.

10. A plasma processing system comprising:
an upper electrode;
a lower electrode;
at least one radio frequency (RF) power source to ignite plasma between said upper electrode and said lower electrode;
a conductive coupling ring, said conductive coupling ring is coupled to said lower electrode to provide a conductive path; and
a plasma-facing-substrate-periphery (PFSP) ring, said PFSP ring being disposed above said conductive coupling ring, said PFSP ring is coupled to at least one of a direct current (DC) ground through an RF filter,
said DC ground through said RF filter and a variable resistor,
a positive DC power source through said RF filter, and
a negative DC power source through said RF filter
to control plasma processing parameters.

11. The plasma processing system of claim 10, wherein said PFSP ring is a hot edge ring.

12. The plasma processing system of claim 10, wherein said PFSP ring is different from a hot edge ring, said PFSP ring can be any type of plasma-facing ring on the periphery of said substrate.

13. The plasma processing system of claim 10, wherein said conductive coupling ring is made of Aluminum.

14. The plasma processing system of claim 10, wherein said PFSP ring is made of silicon.

15. The plasma processing system of claim 10, wherein said RF power source has an RF frequency of about 2 MHz.

16. The plasma processing system of claim 10, wherein said RF power source has an RF frequency of about 27 MHz.

17. The plasma processing system of claim 10, wherein said RF power source has an RF frequency of about 60 MHz.

18. The plasma processing system of claim 10, wherein said plasma processing system is a capacitively-coupled plasma processing system.

CLAIMS

1. A method for processing a substrate in a plasma processing chamber, the method comprising:

providing an upper electrode, a lower electrode, an edge ring concentrically surrounding at least a portion of said lower electrode, and a conductive coupling ring formed of a direct current (DC) conductive material and disposed in the lower electrode below said edge ring;

configuring at least one radio frequency (RF) power source to ignite plasma between said upper electrode and said lower electrode to process said substrate when said substrate is disposed above said lower electrode;

using said conductive coupling ring to provide a conductive path that is coupled to at least said plasma, wherein said edge ring substantially covers and protects said conductive coupling ring from said plasma;

electrically coupling a DC control module via the lower electrode to the conductive coupling ring; and

switching, while the plasma is ignited in the plasma processing chamber, the electrical coupling from being open to a DC ground through an RF filter and a variable resistor, said conductive coupling ring causing setting of a DC bias voltage of the substrate, the switching causing a decrease in mean ion energy of said plasma at said substrate and, while the plasma is ignited, further decreasing the mean ion energy of said plasma at said substrate by increasing said DC bias voltage by adjusting the variable resistor,

wherein the conductive coupling ring disposed in the lower electrode below the edge ring enables current to traverse from the upper electrode, through the plasma when present, through the conductive coupling ring and to the DC control module that is connected to the lower electrode.

2. The method of claim 1, wherein said conductive coupling ring is made of aluminum.

3. The method of claim 1, wherein said RF power source has an RF frequency of about 2 MHz.

4. The method of claim 1, wherein said RF power source has an RF frequency of about 27 MHz.

5. The method of claim 1, wherein said RF power source has an RF frequency of about 60 MHz.

6. The method of claim 1, wherein said plasma processing system is a capacitively-coupled plasma processing system.

7. The method of claim 1, further comprising, during said processing said substrate, opening a switch between said RF filter and said DC ground to cause said substrate to have a negative DC bias voltage.

8. The method of claim 1 further comprising closing a switch between said RF filter and said DC ground to increase a DC bias voltage of said substrate.

9. The method of claim 1 further comprising closing a switch between said RF filter and said DC ground to increase a voltage potential of said plasma.

10. The method of claim 1 further comprising, during said processing said substrate, closing a switch between said RF filter and said DC ground to increase density of said plasma across said substrate.

11. A method for processing a substrate in a plasma processing chamber, the method comprising:

providing an upper electrode, a lower electrode, an edge ring concentrically surrounding at least a portion of said lower electrode, and a conductive coupling ring formed of a direct current (DC) conductive material and disposed in the lower electrode below said edge ring;

configuring at least one radio frequency (RF) power source to ignite plasma between said upper electrode and said lower electrode to process said substrate when said substrate is disposed above said lower electrode;

using said conductive coupling ring disposed in the lower electrode to provide a conductive path from said upper electrode through said plasma, when present, through said conductive coupling ring and to a DC control module that is coupled to said lower electrode, the conductive path initially being electrically floating;

coupling the conductive path to DC ground from the floating state via a switch of said DC control module while the plasma is ignited, the conductive path being via an RF filter and a variable resistor of said DC control module; and

adjusting, while the plasma is ignited, the variable resistor to increase a DC bias voltage of the substrate via the conductive path, the increase in DC bias voltage causing a decrease in mean ion energy of said plasma at the substrate.

12. The method of claim 11, wherein said conductive coupling ring is made of aluminum.

13. The method of claim 11, wherein said RF power source has an RF frequency of about 2 MHz.

14. The method of claim 11, wherein said RF power source has an RF frequency of about 27 MHz.

15. The method of claim 11, wherein said RF power source has an RF frequency of about 60 MHz.

16. The method of claim 11, wherein said plasma processing system is a capacitively-coupled plasma processing system.

17. The method of claim 11, further comprising, during said processing said substrate, opening a switch between said RF filter and said DC ground to cause said substrate to have a negative DC bias voltage.

18. The method of claim 11 further comprising closing a switch between said RF filter and said DC ground to increase a DC bias voltage of said substrate.

19. The method of claim 11 further comprising closing a switch between said RF filter and said DC ground to increase a voltage potential of said plasma.

20. The method of claim 11 further comprising, during said processing said substrate, closing a switch between said RF filter and said DC ground to increase density of said plasma across said substrate.