

Claims

1. A plasma processing chamber configured to clean a bevel edge of a substrate, comprising:

a substrate support configured to receive the substrate;

a bottom edge electrode surrounding the substrate support, the bottom edge electrode and the substrate support being electrically isolated from one another by a bottom dielectric ring, a surface of the bottom edge electrode facing the substrate being covered by a bottom thin dielectric layer; and

a top edge electrode surrounding a top insulator plate opposing the substrate support, the top edge electrode being electrically grounded, a surface of the top edge electrode facing the substrate being covered by a top thin dielectric layer, the top edge electrode and the bottom edge electrode opposing one another and being configured to generate a cleaning plasma to clean the bevel edge of the substrate.

2. The plasma processing chamber of claim 1, wherein the thickness of the top thin dielectric layer and the bottom thin dielectric layer both are between about 0.01 mm to about 1 mm.

3. The plasma processing chamber of claim 1, wherein the bottom edge electrode is coupled to an RF power supply and the top edge electrode is electrically grounded.

4. The plasma processing chamber of claim 1, wherein the top edge electrode is coupled to an RF power supply and the bottom edge electrode is electrically grounded.

5. The plasma processing chamber of claim 3, wherein a frequency of a RF power provided by the RF power supply is between about 2 MHz and about 60 MHz.

6. The plasma processing chamber of claim 1, further comprising:

a top insulating ring surrounding and being coupled to the top edge electrode, wherein a surface of the top insulating ring that faces the substrate aligns with the surface of the top edge electrode that faces the substrate; and

a bottom insulating ring surrounding and coupled to the bottom edge electrode, wherein a surface of the bottom insulating ring that faces the top insulating ring aligns with the surface of the bottom edge electrode that opposes the top edge electrode, wherein the top insulating ring and the bottom insulating ring confine the cleaning plasma generated by the top edge electrode and the bottom edge electrode.

7. The plasma processing chamber of claim 1, wherein the bottom thin dielectric layer and the top thin dielectric layer are made of a material inert to the cleaning plasma to prevent corrosion of the top edge electrode and the bottom edge electrode and to reduce particle counts in the processing chamber.

8. The plasma processing chamber of claim 1, wherein the material is selected from the group consisting of yttrium oxide (Y_2O_3), alumina (Al_2O_3), silicon carbide (SiC).

9. The plasma processing chamber of claim 1, wherein ratio of a distance between the bottom edge electrode or top edge electrode to a nearest ground to a distance between the top edge electrode and the bottom edge electrode is greater than about 4:1.

10. The plasma processing chamber of claim 1, wherein the substrate support is made of a conductive material and is coupled to a resistor with a resistance greater than about 1 Mohm.

11. The plasma processing chamber of claim 1, wherein the distance between the insulator plate and the a of the substrate facing the insulator plate is less than about 1 mm.

12. The plasma processing chamber of claim 1, wherein the distance between the top edge electrode and the bottom edge electrode is between about 0.5 cm to about 2.5 cm.

13. A method of cleaning a bevel edge of a substrate in an processing chamber, comprising:

placing a substrate on a substrate support in the processing chamber;

flowing a cleaning gas into the processing chamber; and

generating a cleaning plasma near the bevel edge of the substrate to clean the bevel edge by powering a bottom edge electrode with a RF power source and by grounding a top edge electrode, wherein

the bottom edge electrode surrounds the substrate support, the bottom edge electrode and the bottom electrode being electrically isolated from one another by a bottom dielectric ring, a surface of the bottom edge electrode facing the substrate being covered by a bottom thin dielectric layer, the top edge electrode surrounding an insulator plate which opposes the substrate support, a surface of the top edge electrode facing the substrate being covered by a top thin dielectric layer.

14. The method of claim 13, wherein the bottom thin dielectric layer and the top thin dielectric layer are made of a material inert to the cleaning plasma to prevent corrosion of the top edge electrode and the bottom edge electrode and to reduce particle counts in the processing chamber.

15. The method of claim 14, wherein the material is selected from the group consisting of yttrium oxide (Y_2O_3), alumina (Al_2O_3), silicon carbide (SiC).

16. The method of claim 13, wherein the substrate support is configured to having a high resistivity to prevent drawing RF power from the RF power source coupled to the bottom edge electrode.

17. The method of claim 13, wherein a distance between a surface of the substrate and the insulator plate opposing the substrate support is less than 1 mm to prevent plasma being formed on a front surface away from the edge of the substrate.

18. The method of claim 13, wherein the cleaning gas comprises either an oxygen-containing or a fluorine-containing gas.

19. The method of claim 13, further comprising:

keeping a distance between the top edge electrode and the bottom edge electrode is between about 0.5 cm to about 2.5 cm.

20. The method of claim 13, wherein ratio of a distance between the bottom edge electrode or top edge electrode to a nearest ground to a distance between the top edge electrode and the bottom edge electrode is greater than about 4:1 to confine the cleaning plasma to be near the bevel edge.

21. A method of cleaning a chamber interior of an processing chamber, comprising:

removing a substrate from the processing chamber;

flowing a cleaning gas into the processing chamber; and

generating a cleaning plasma in the processing chamber to clean the chamber interior by powering a bottom edge electrode with a RF power source and by grounding a top edge electrode, wherein

the bottom edge electrode surrounds the substrate support, the bottom edge electrode and the bottom electrode being electrically isolated from one another by a bottom dielectric ring, a surface of the bottom edge electrode facing the substrate being covered by a bottom thin dielectric layer, the top edge electrode surrounding an insulator plate which opposes the substrate support, a surface of the top edge electrode facing the substrate being covered by a top thin dielectric layer.

22. The method of claim 21, wherein the bottom thin dielectric layer and the top thin dielectric layer are made of a material inert to the cleaning plasma to prevent corrosion of the top edge electrode and the bottom edge electrode and to reduce particle counts in the processing chamber.

23. The method of claim 22, wherein the material is selected from the group consisting of yttrium oxide (Y_2O_3), alumina (Al_2O_3), silicon carbide (SiC).

Claims

1. A plasma processing chamber configured to clean a bevel edge of a substrate, comprising:

a substrate support configured to receive the substrate;

a bottom edge electrode surrounding the substrate support, the bottom edge electrode and the substrate support being electrically isolated from one another by a bottom dielectric ring, a surface of the bottom edge electrode, facing the substrate, being covered by a bottom thin dielectric layer, the bottom dielectric ring having a step defined between a first level disposed at a height of the substrate support and a second level disposed at a height of the bottom edge electrode;

a bottom insulating ring surrounding the bottom edge electrode;

a top edge electrode surrounding a top insulator plate that is opposing the substrate support, the top edge electrode being electrically grounded, the top edge electrode and the top insulator plate isolated from one another by a top dielectric ring; and

a top insulating ring surrounding the top edge electrode;

wherein a surface of the top edge electrode facing the substrate being covered by a top thin dielectric layer, the top edge electrode and the bottom edge electrode opposing one another;

wherein during operation a cleaning plasma to clean the bevel edge of the substrate is generated between the top edge electrode and the bottom edge electrode, wherein generation of the cleaning plasma uses a gas chemistry that is introduced into the plasma processing chamber from a center feed in the top insulator plate that allows the gas chemistry to flow over the substrate toward the bevel edge of the substrate;

wherein a surface of the top insulating ring that faces the substrate aligns with the surface of the top edge electrode that faces the substrate; and

wherein a surface of the bottom insulating ring that faces the top insulating ring aligns with the surface of the bottom edge electrode that opposes the top edge electrode, wherein the top insulating ring and the bottom insulating ring confine the cleaning plasma generated by the top edge electrode and the bottom edge electrode;

wherein the bottom edge electrode is coupled to an RF power supply;

wherein the separation distance between the top edge electrode and the bottom edge electrode is (D_{EE}), and a nearest ground distance (D_W) is a distance to a chamber wall of the plasma processing apparatus and one of the top or bottom edge electrodes, wherein a ratio of D_W/D_{EE} is at least 4:1.

2. The plasma processing chamber of claim 1, wherein the thickness of the top thin dielectric layer and the bottom thin dielectric layer both are between about 0.01 mm to about 1 mm.

3. The plasma processing chamber of claim 1, wherein a frequency of a RF power provided by the RF power supply is between about 2 MHz and about 60 MHz.

4. The plasma processing chamber of claim 1, wherein the bottom thin dielectric layer and the top thin dielectric layer are made of a material inert to the cleaning plasma to prevent corrosion of the top edge electrode and the bottom edge electrode and to reduce particle counts in the processing chamber.

5. The plasma processing chamber of claim 4, wherein the material is selected from the group consisting of yttrium oxide (Y_2O_3), alumina (Al_2O_3), silicon carbide (SiC).

6. The plasma processing chamber of claim 1, wherein the substrate support is made of a conductive material and is coupled to a resistor with a resistance greater than about 1 Mohm.
7. The plasma processing chamber of claim 1, wherein the distance between the top insulator plate and a surface of the substrate facing the insulator plate is less than about 1 mm.
8. The plasma processing chamber of claim 1, wherein the distance between the top edge electrode and the bottom edge electrode is between about 0.5 cm to about 2.5cm.
9. A plasma processing apparatus for cleaning of a bevel edge of a substrate, comprising:
 - in a chamber, including,
 - a substrate support for supporting a substrate;
 - a top insulator plate positioned over the substrate support, a distance between a surface of a wafer when disposed over the substrate support and the top insulator plate is set to less than about 1 mm;
 - a top dielectric ring surrounding the top insulator plate;
 - a top edge electrode configured to surround the top dielectric ring, the top dielectric ring having a step defined between a first level disposed at a height of the top insulator plate and a second level disposed at a height of the top edge electrode;
 - a top insulating ring surrounding the top edge electrode;
 - a bottom dielectric ring surrounding the substrate support;

a bottom edge electrode surrounding the bottom dielectric ring, the bottom dielectric ring having a step defined between a first level disposed at a height of the substrate support and a second level disposed at a height of the bottom edge electrode; and

a bottom insulating ring surrounding the bottom electrode;

wherein each of the top and bottom edge electrodes have a dielectric layer disposed on respective surfaces, the respective surfaces arranged to face one another;

wherein the top and bottom edge electrodes set to a separation distance of between about 0.5 cm and about 2.5cm, the separation distance defining an area for producing a plasma to process a bevel edge of the substrate when present and when the chamber is in operation;

wherein the top insulator plate includes a gas feed in the center to enable introduction of a gas chemistry into the plasma processing apparatus, the gas chemistry configured to flow over the substrate to the bevel edge of the substrate to produce the plasma between the top and bottom edge electrodes;

wherein each of the bottom insulating ring and the top insulating ring have surfaces that face each other and radially extend outward from respective surfaces of the bottom edge electrode and top edge electrode to define a extended confinement region;

wherein the bottom edge electrode is coupled to an RF power supply and the top edge electrode is electrically grounded;

wherein the separation distance between the top edge electrode and the bottom edge electrode is (D_{EE}), and a nearest ground distance (D_w) is a distance to a chamber wall of the plasma processing apparatus and one of the top or bottom edge electrodes, wherein a ratio of D_w/D_{EE} is at least 4:1.

10. The plasma processing apparatus of claim 9, wherein the dielectric layer is selected from the group consisting of yttrium oxide (Y_2O_3), alumina (Al_2O_3), silicon carbide (SiC).
11. The plasma processing apparatus of claim 9, wherein a frequency of a RF power provided by the RF power supply is between about 2 MHz and about 60 MHz.