

**CLAUSES**

1. A plasma etching processing chamber configured to etch a thin film on a bevel edge of a substrate, comprising:

a bottom edge electrode surrounding a substrate support in the plasma processing chamber, wherein the substrate support is configured to receive the substrate and the bottom edge electrode and the substrate support are electrically isolated from each other by a bottom dielectric ring;

a top edge electrode surrounding a gas distribution plate opposing the substrate support, wherein the top edge electrode and the gas delivery plate are electrically isolated from each other by a top dielectric ring, and the top edge electrode and the bottom edge electrode are configured to generate an etching plasma near the bevel edge to remove the thin film on the bevel edge of the substrate, wherein the distance between the top edge electrode and the bottom edge electrode is less than about 1.5 cm to confine the treatment plasma;

a center gas feed embedded in the gas delivery plate, wherein the center gas feed is configured to delivery either an etching process gas or a tuning gas into the plasma processing chamber through the center gas feed;

a center gas selection controller coupled to a center gas manifold, wherein the center gas manifold is coupled to a plurality of etching processing and turning gases, and wherein the center gas selection controller is coupled to the center gas feed and selects the etching process gas or the tuning gas delivered into the plasma processing chamber;

an edge gas feed configured to deliver either the etching process gas or the tuning gas toward the bevel edge of the substrate, wherein the edge gas feed is disposed above the substrate; and

an edge gas selection controller coupled to an edge gas manifold, wherein the edge gas manifold is coupled to the plurality of etching processing and turning gases, and wherein the edge gas selection controller is coupled to edge gas feed and selects the etching process gas or the tuning gas delivered into the plasma processing chamber through the edge gas feed.

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

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

3. The plasma etching processing chamber of claim 2, 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.
4. The plasma etching processing chamber of claim 1, wherein the etching process gas is fed from the edge gas feed and the tuning gas is fed from the center gas feed.
5. The plasma etching processing chamber of claim 1, wherein there are more than one center gas feeds and more than one edge gas feeds.
6. The plasma etching processing chamber of claim 1, wherein both the center gas manifold and the edge gas manifold are coupled to a plurality of processing gases.
7. The plasma etching processing chamber of claim 2, wherein the edge gas feed is located between the top dielectric ring and the top edge electrode.
8. The plasma etching processing chamber of claim 1, wherein the thin film on the bevel edge being etched is selected from a group consisting of a dielectric film, a metal film, a photoresist film, a semiconductor film, and a combination of the these films.
9. The plasma etching processing chamber of claim 1, wherein thin film is a dielectric film, and the etching process gas includes an oxygen-containing gas, and a fluorine-containing gas.
10. The plasma etching processing chamber of claim 1, wherein the tuning gas includes nitrogen or an inert gas.
11. The plasma etching processing chamber of claim 1, wherein the top edge electrode is coupled to a RF power source to supply power and the bottom edge electrode is grounded, or the bottom edge electrode is coupled to a RF power source to supply power and the top edge electrode is grounded to generate the treatment plasma

12. The plasma etching processing chamber of claim 1, wherein the distance between the gas delivery plate and the surface of the substrate facing the gas delivery plate is less than about 0.6 mm.
13. The plasma etching processing chamber of claim 2, wherein a ratio of a width of the bottom insulating ring to the distance between the top edge electrode and the bottom edge electrode is less than about 4:1.
14. The plasma etching processing chamber of claim 1, wherein the etching plasma near the bevel edge has zero etching at greater than about 1 mm from an edge of the substrate.
15. The plasma etching processing chamber of claim 7, wherein there are a plurality of edge gas feeds evenly distributed around the outer diameter of the top dielectric ring.
16. A method of etching a thin film on a bevel edge of a substrate in a plasma etching chamber, comprising:
  - placing the substrate on a substrate support in the plasma etching chamber;
  - flowing an etching process gas through a center gas feed located or an edge gas feed, wherein the center gas feed and the edge gas feed are disposed above the substrate support;
  - flowing a tuning process gas through the center gas feed located or the edge gas feed, wherein the tuning gas is used to change the etching plasma characteristics at the bevel edge;
  - generating an etching plasma near the bevel edge of the substrate to etch the thin film on the bevel edge by powering a bottom edge electrode or a top edge electrode with a RF power source and grounding the edge electrode that is not powered by the RF power source, wherein the bottom edge electrode surrounds the substrate support and the top edge electrode surrounds the gas distribution plate, wherein the distance between the top edge electrode and the bottom edge electrode is less than about 1.5 cm to confine the treatment plasma; and
  - etching the thin film by the generated etching plasma.
17. The plasma method of claim 16, wherein the thin film on the bevel edge being etched is selected from a group consisting of a dielectric film, a metal film, a photoresist film, a semiconductor film, and a combination of the these films.
18. The etching of claim 16, wherein thin film is a dielectric film, and the etching process gas includes an oxygen-containing gas, and a fluorine-containing gas.
19. The method of claim 16, wherein the tuning gas includes nitrogen or an inert gas.

20. The method of claim 16, wherein the distance between the gas delivery plate and the surface of the substrate facing the gas delivery plate is less than about 0.6 mm to prevent plasma being formed between the gas delivery plate and the substrate.
21. The method of claim 16, wherein the etching plasma near the bevel edge has zero etching at greater than about 2 mm from an edge of the substrate.
22. The method of claim 16, wherein the etching process gas is fed from the edge gas feed and the tuning gas is fed from the center gas feed.

Claims:

1. A method of etching a film on a bevel edge of a substrate in a plasma etching chamber, comprising:

providing the substrate on a substrate support in the plasma etching chamber, the plasma etching chamber having a top edge electrode and a bottom edge electrode disposed to surround the substrate support;

positioning a gas delivery plate in the plasma processing chamber at a distance of less than about 0.6 mm from the substrate support;

flowing an etching process gas through a plurality of edge gas feeds disposed along a periphery of the gas delivery plate, the periphery of the gas deliver plate being oriented above the substrate support and the bevel edge of the substrate, the flowing further directed to a space between the top edge electrode and bottom edge electrode;

flowing a tuning gas through a center gas feed of the gas delivery plate, the tuning gas directed over a center region of the substrate so as to flow way from the center region and toward the bevel edge of the substrate and mix with the etching process gas; and

applying RF power to one of the top or bottom edge electrodes, the applied power acting to strike a plasma to etch the film of the bevel edge of the substrate;

wherein the flown etching process gas through the plurality of edge gas feeds is defined from an  $\text{NF}_3$  gas and a  $\text{CO}_2$  gas, and the tuning gas is  $\text{N}_2$  flown from the center gas feed.

2. The method of claim 1, further comprising, arranging a distance between the top and bottom edge electrodes to be less than about 1.5 cm.

3. The method of claim 1, wherein the tuning gas is provided with flow rate of between about 300 sccm and about 750 sccm.

4. The method of claim 1, wherein the tuning gas is provided as a mixture of two or more of  $\text{N}_2$ , Ar, and He, setting the mixture provides for tuning an etching profile at the bevel edge of substrate.

5. The method of claim 1, wherein the film is one of a dielectric film, or a metal film, or a photoresist film, or a semiconductor film, or a combination thereof.

6. A method of etching a film on a bevel edge of a substrate in a plasma etching chamber, comprising:

providing the substrate on a substrate support in the plasma etching chamber, the plasma etching chamber having a top edge electrode and a bottom edge electrode disposed to surround the substrate support;

positioning a gas delivery plate in the plasma processing chamber at a distance of less than about 0.6 mm from the substrate support;

flowing an etching process gas through a plurality of edge gas feeds disposed along a periphery of the gas delivery plate, the periphery of the gas deliver plate being oriented above the substrate support and the bevel edge of the substrate, the flowing further directed to a space between the top edge electrode and bottom edge electrode;

flowing a tuning gas through a center gas feed of the gas delivery plate, the tuning gas directed over a center region of the substrate so as to flow way from the center region and toward the bevel edge of the substrate and mix with the etching process gas; and

applying RF power to one of the top or bottom edge electrodes, the applied power acting to strike a plasma to etch the film of the bevel edge of the substrate;

wherein the film is a dielectric material and the etching process gas includes  $\text{NF}_3$  and  $\text{CO}_2$ , and the tuning gas includes at least one of nitrogen ( $\text{N}_2$ ), argon (Ar), and helium (He).

7. The method of claim 6, wherein the film is one of a dielectric film, or a metal film, or a photoresist film, or a semiconductor film, or a combination thereof.

8. A method of etching a film on a bevel edge of a substrate in a plasma etching chamber, comprising:

providing the substrate on a substrate support in the plasma etching chamber, the plasma etching chamber having a top edge electrode and a bottom edge electrode disposed to surround the substrate support;

positioning a gas delivery plate in the plasma processing chamber at a distance of less than about 0.6 mm from the substrate support;

flowing an etching process gas through a plurality of edge gas feeds disposed along a periphery of the gas delivery plate, the periphery of the gas deliver plate being oriented above the substrate support and the bevel edge of the substrate, the flowing further directed to a space between the top edge electrode and bottom edge electrode;

flowing a tuning gas through a center gas feed of the gas delivery plate, the tuning gas directed over a center region of the substrate so as to flow way from the center region and toward the bevel edge of the substrate and mix with the etching process gas; and

applying RF power to one of the top or bottom edge electrodes, the applied power acting to strike a plasma to etch the film of the bevel edge of the substrate, wherein,

the tuning gas provided from the center feed includes  $\text{NF}_3$  and  $\text{CO}_2$ , and  
adjusting a flow rate of  $\text{CO}_2$ .

9. The method of claim 8, further including  $\text{N}_2$  as an additional non-reactive gas supplied from the center feed.

10. The method of claim 8, wherein the film is one of a dielectric film, or a metal film, or a photoresist film, or a semiconductor film, or a combination thereof.

11. The method of claim 8, wherein adjusting the flow rate of  $\text{CO}_2$  up increases etch rate in the bevel edge closer to an edge of the substrate.

12. The method of claim 11, wherein the flow rate of  $\text{CO}_2$  is adjusted between 200 sccm to 500 sccm.