

Claims

1. An arrangement for controlling bevel etch rate during plasma processing within a processing chamber of a plasma processing system, comprising:

a power source;

5 a gas distribution system;

a lower electrode, wherein said lower electrode is configured at least for supporting a substrate during said plasma processing;

a top ring electrode positioned to cover a top edge of said substrate;

a bottom ring electrode positioned to cover a bottom edge of said substrate;

10 a first match arrangement disposed between said top ring electrode and ground, said first match arrangement is configured at least to control current flowing through said top ring electrode to control amount of plasma available for etching at least a part of a top edge of said substrate, wherein the first match arrangement includes a first parallel circuit comprising a series circuit of a variable capacitor and a first inductor connected in parallel to a series circuit of a second inductor and a switch;

15 a second match arrangement disposed between said bottom ring electrode and ground and is configured to control said current flowing through said bottom ring electrode to control amount of plasma available for etching at least a part of a bottom edge of said substrate, wherein the second match arrangement includes a second parallel circuit comprising a series circuit of a variable capacitor and a first inductor connected in parallel to a series circuit of a second inductor and a switch; and

20 an upper electrode positioned directly above said substrate, the upper electrode having a surface that substantially covers a top surface of the substrate except for the top edge of the substrate, the upper electrode having an extension that extends the surface of the upper electrode up to the top edge of the substrate, the upper electrode and the extension of the upper electrode being disposed over the top surface of the substrate such that a gap that is less than about 0.35 mm is maintained to prevent formation
25 of plasma in an area between the upper electrode and the top surface of the substrate;

a first ceramic element is disposed between the extension and the top ring electrode;

a second ceramic element is disposed between the lower electrode and the bottom ring electrode; and

30 a third match arrangement, wherein said third match arrangement is coupled to said upper electrode, wherein said third match arrangement is configured to control said current flowing through said upper electrode to change said upper electrode from a grounded state to a floating state, thereby minimizing plasma formation between said upper electrode and said lower electrode;

wherein said third match arrangement includes at least a switch, an inductor, and a variable capacitor, the inductor is in series with the variable capacitor of the third match arrangement,

35 wherein said switch of the third match arrangement is set to a closed position,

wherein said inductor and said capacitor of the third match arrangement is tuned to be in parallel resonance with an operating frequency of said processing chamber to set said upper electrode at said floating state.

40 2. The arrangement of claim 1 wherein for said first match arrangement, said switch is set to an open position,

wherein said first inductor and said variable capacitor are in series resonance with an operating frequency of said processing chamber to control etching on said substrate top edge.

3. The arrangement of claim 1 wherein for said second match arrangement,
5 said switch is set to an open position,
wherein said first inductor and said variable capacitor are in series resonance with an operating frequency of said processing chamber to control etching on said substrate bottom edge.

4. The arrangement of claim 1 wherein said plasma processing system is a capacitively-coupled
10 processing system.

5. The arrangement of claim 1 wherein said power source is a radio frequency power source that is coupled to said lower electrode by way of an RF match.

6. The arrangement of claim 1, wherein the first ceramic element surrounds the extension of the
15 upper electrode.

7. The arrangement of claim 1, wherein the second ceramic element surrounds the lower electrode.

8. A plasma processing system, comprising:
20 a power source;
a gas distribution system;
a lower electrode, wherein said lower electrode is configured at least for supporting a substrate during said plasma processing;

25 an upper electrode having an extension that extends a surface of the upper electrode up to a top edge of the substrate, said upper electrode and the extension disposed over the top surface of the substrate define a minimized gap between said upper electrode and said lower electrode, a size of the gap defined to prevent formation of a plasma in an area between the upper electrode and the lower electrode;

30 a top ring electrode positioned to cover the top edge of said substrate and surrounding the upper electrode;

a bottom ring electrode positioned to cover a bottom edge of said substrate and surrounding said lower electrode, wherein the top ring electrode is arranged opposite the bottom ring electrode to define a region there-between for forming plasma around a bevel edge of the substrate when the substrate is disposed over the lower electrode;

35 a first match arrangement including a first parallel circuit electrically connected between the top ring electrode and ground, the first parallel circuit includes a series circuit of a variable capacitor and a first inductor connected in parallel to a series circuit of a second inductor and a switch;

40 a second match arrangement including a second parallel circuit electrically connected between the bottom ring electrode and ground, the second parallel circuit includes a series circuit of a variable capacitor and a first inductor connected in parallel to a series circuit of a second inductor and a switch; and

a third match arrangement being electrically coupled to said upper electrode, a switch from the third match arrangement and the switch from the first and the second match arrangements used to

selectively control plasma formation in specific areas within a processing chamber of the plasma processing system.

9. The plasma processing system of claim 8, wherein the third match arrangement includes a third parallel circuit electrically connected between the upper electrode and ground, the third parallel circuit includes,

a first circuit portion including a variable capacitor in series with an inductor;

a second circuit portion including a first switch in series with an inductor;

a third circuit portion including a second switch in series with a resistor;

wherein the first, second and third circuit portions are in parallel with each other between the upper electrode and ground and wherein the variable capacitor and the inductor of the first circuit portion are in parallel resonance with an operating frequency of said processing chamber and the first switch is set in a closed position to allow the upper electrode to be set at floating state.

10. The arrangement of claim 8, wherein for said first match arrangement,

said switch is set to an open position,

wherein said first inductor and said variable capacitor are in series resonance with an operating frequency of said processing chamber to control etching on said substrate top edge.

11. The arrangement of claim 8, wherein for said second match arrangement,

said switch is set to an open position,

wherein said first inductor and said variable capacitor are in series resonance with an operating frequency of said processing chamber to control etching on said substrate bottom edge.

12. The plasma processing system of claim 8, further includes,

a first ceramic element is disposed between the extension and the top ring electrode; and

a second ceramic element is disposed between the lower electrode and the bottom ring electrode.

13. The plasma processing system of claim 12, wherein the first ceramic element surrounds the extension of the upper electrode and the second ceramic element surrounds the lower electrode.

14. A plasma processing system, comprising:

an RF power source;

a gas distribution system;

a lower electrode, wherein said lower electrode is configured at least for supporting a substrate during said plasma processing;

an upper electrode disposed over the lower electrode, the upper electrode including an extension that extends a surface of the upper electrode up to a top edge of the substrate, wherein when the upper electrode is moved, the upper electrode and the extension are disposed to define a minimal gap between the surface of the upper electrode and a top surface of the substrate so as to prevent formation of a plasma in an area defined between said surface of the upper electrode and the top surface of said substrate;

a top ring electrode positioned to cover the top edge of said substrate and surrounding the upper electrode;

a bottom ring electrode positioned to cover a bottom edge of said substrate and surrounding said lower electrode, wherein the top ring electrode is arranged opposite the bottom ring electrode to define a region there-between for forming plasma around a bevel edge of the substrate when the substrate is disposed over the lower electrode;

a first match arrangement including a first parallel circuit electrically connected between the top ring electrode and ground, the first parallel circuit includes a series circuit of a variable capacitor and a first inductor in parallel to a series circuit of a second inductor and a switch;

a second match arrangement including a second parallel circuit electrically connected between the bottom ring electrode and ground, the second parallel circuit includes a series circuit of a variable capacitor and a first inductor in parallel to a series circuit of a second inductor and a switch; and

a third match arrangement being electrically coupled to said upper electrode, wherein the third match arrangement includes a third parallel circuit electrically connected between the upper electrode and ground, wherein third parallel circuit includes,

a first circuit portion including a variable capacitor in series with an inductor;

a second circuit portion including a first switch in series with an inductor;

a third circuit portion including a second switch in series with a resistor;

wherein the first, second and third circuit portions are in parallel with each other between the upper electrode and ground and wherein the switch from the first, the second and the third match arrangement used to selectively control plasma formation in specific areas within a processing chamber of the plasma processing system.

15. The plasma processing system of claim 14, further comprising,

an upper ceramic ring disposed around the upper electrode and adjacent to the upper ring electrode; and

a lower ceramic ring disposed round the lower electrode and adjacent to the bottom ring electrode.

16. The plasma processing system of claim 14, wherein the first, second and third match arrangements are coupled to ground and not to the RF power source, the RF power source only being coupled to the lower electrode via an RF match to define a capacitively-coupled processing system.