

What is claimed is:

Claims

1. A plasma processing chamber configured to generate a plasma, comprising:
a bottom electrode assembly with an bottom electrode, wherein the bottom electrode is configured to receive a substrate; and
a top electrode assembly with a top electrode and an inductive coil surrounding the top electrode and the inductive coil is configured to convert a gas into a plasma within a region defined within the chamber, the region being outside an area defined above a top surface of the bottom electrode.
2. The plasma processing chamber of claim 1, further comprising:
a Faraday shield disposed beneath the inductive coil.
3. The plasma processing chamber of claim 1, further comprising:
a plurality of confinement rings surrounding a volume within which the plasma is substantially disposed, wherein the plurality of confinement rings are suspended parallel to bottom electrode within the plasma processing chamber.
4. The plasma processing chamber of claim 1, further comprising:
a conductive ring surrounding the bottom electrode, wherein the conductive ring is separated from the bottom electrode by a dielectric ring.

5. The plasma processing chamber of claim 1, wherein a RF power source is coupled to the inductive coil to create the plasma by supplying RF power with single frequency or multiple frequencies in the range between about 400 kHz to about 27 MHz.
6. The plasma processing chamber of claim 1, wherein the inductive coil is separated from the top electrode by a dielectric material.
7. The plasma processing chamber of claim 1, wherein the plasma is chamber cleaning plasma.
8. The plasma processing chamber of claim 1, wherein the top electrode is coupled to a ground.
9. The plasma processing chamber of claim 1, wherein the top electrode, the inductive coil and the bottom electrode are configured to convert an etching gas(es) into an etching plasma.
10. The plasma processing chamber of claim 9, wherein the inductive coil and either the top electrode or the bottom electrode are RF powered to convert the etching gas(es) into the etching plasma.
11. A plasma processing chamber configured to generate a plasma, comprising:
 - a bottom electrode assembly with an bottom electrode, wherein the bottom electrode is configured to receive a substrate; and

a top electrode assembly including a top capacitive electrode, an inner and an outer inductive coils disposed above the top capacitive electrode, wherein the outer inductive coil is disposed over a surface, the surface being defined outside of a circumference of the bottom electrode, wherein the top capacitive electrode is disposed directly above the bottom electrode and the bottom electrode and the top capacitive electrode are configured to convert a first gas into a first plasma and the outer inductive coil is configured to convert a second gas into a second plasma.

12. The plasma processing chamber of claim 11, further comprising:

a Faraday shield disposed beneath the inner and outer inductive coils.

13. The plasma processing chamber of claim 11, further comprising:

a plurality of confinement rings surrounding a volume within which the first plasma or the second plasma is substantially disposed, wherein the plurality of confinement rings are suspended parallel to bottom electrode within the plasma processing chamber.

14. The plasma processing chamber of claim 11, further comprising:

a conductive ring surrounding the bottom electrode, wherein the conductive ring is separated from the bottom electrode by a dielectric ring and the conductive ring is grounded during plasma processing.

15. The plasma processing chamber of claim 11, wherein the second plasma is substantially disposed in a region defined within the plasma processing chamber, the region being outside an area defined above a top surface of the bottom electrode.

16. The plasma processing chamber of claim 15, wherein the second plasma is a chamber cleaning plasma and the bottom electrode is grounded when the second plasma is generated.

17. The plasma processing chamber of claim 11, wherein a RF power source is coupled to the outer inductive coil to convert the second gas into the second plasma by supplying RF power with single frequency or multiple frequencies in the range between about 400 kHz to about 27 MHz.

18. The plasma processing chamber of claim 11, wherein the bottom electrode and the top capacitive electrode are RF powered to convert the first gas into the first plasma, and inner and outer inductive coils are also RF when the first gas is converted into the first plasma.

19. The plasma processing chamber of claim 18, wherein a RF power source is coupled to either the top capacitive electrode or the bottom electrode and another RF power source is coupled to the inner and outer inductive coils.

20. A method of generating a plasma in a plasma processing chamber, comprising method operations of:

supplying a process gas into the plasma processing chamber; and

generating a plasma by powering an inductive coil which is part of a top electrode assembly and surrounds a periphery of a top electrode of the top electrode assembly, wherein

the inductive coil is also disposed over a surface defined outside of a circumference of a bottom electrode disposed beneath the top capacitive electrode.

21. The method of claim 20, wherein the method operation of generating the plasma includes preventing power from reaching the bottom electrode and keeping the bottom electrode floating.

22. The method of claim 20, wherein the plasma is a chamber cleaning plasma and is substantially disposed outside a surface of the bottom electrode.

23. The method of claim 20, wherein during the method operation of generating a plasma, the top electrode is grounded during the plasma generating operation.

24. The method of claim 20, wherein a Faraday shield is disposed beneath the inductive coil to provide RF grounding path for the power from the bottom electrode and to suppress capacitive coupling from the inductive coil.

What is claimed is:

1. A plasma processing chamber configured to generate a plasma, comprising:
a bottom electrode assembly having an bottom electrode and a conductive ring surrounding the bottom electrode, wherein the conductive ring is separated from the bottom electrode by a dielectric ring and the conductive ring is grounded, wherein the bottom electrode is configured to receive a substrate; and
a top electrode assembly including a top capacitive electrode, an inner and an outer inductive coil disposed above the top capacitive electrode,
the outer inductive coil is disposed over a surface of the conductive ring that is defined outside of a circumference of the bottom electrode, and
the inner inductive coil is disposed over a surface of the bottom electrode and positioned inside of the outer inductive coil, such that the outer inductive coil and the inner inductive coil are each coupled to a separate power supply to define a region between the outer inductive coil and the conductive ring with inductive power separately from a region between the inner inductive coil and the bottom electrode.
2. The plasma processing chamber of claim 1, further comprising:
a plurality of confinement rings surrounding a volume within which the first plasma or the second plasma is substantially disposed, wherein the plurality of confinement rings are suspended parallel to bottom electrode within the plasma processing chamber.
3. The plasma processing chamber of claim 1, wherein one of the separate power supplies is an RF power source is coupled to the outer inductive coil to supply RF power with single frequency or multiple frequencies in the range between about 400 kHz to about 27 MHz.
4. The plasma processing chamber of claim 1, wherein the top capacitive electrode is coupled to ground and the bottom electrode is coupled to RF power.
5. The plasma processing chamber of claim 4, wherein a RF power source is coupled to either the top capacitive electrode or the bottom electrode.
6. The plasma processing chamber of claim 1, wherein both the inner and the outer inductive coils are below a chamber cover and buried in a dielectric material encircled by

a conductive block, and wherein a Faraday shield is disposed beneath the dielectric material, and wherein the conductive block makes electrical contact with the Faraday shield to provide a grounding path to RF power coming from any of the electrodes.

7. A plasma processing chamber, comprising:

(a) a top electrode assembly including,

(i) a top capacitive electrode for processing a semiconductor wafer in the processing chamber; and

(ii) an inner inductive coil and an outer inductive coil for chamber cleaning or assisting in the processing of the semiconductor wafer;

(b) a bottom electrode disposed under the top capacitive electrode;

(c) a dielectric ring surrounding the bottom electrode;

(d) a conductive ring, being coupled to ground, surrounds the bottom electrode, such that the dielectric ring is disposed between the conductive ring and the bottom electrode;

wherein the inner inductive coil is disposed over the bottom electrode and the outer inductive coil is disposed over the conductive ring.

8. A plasma processing chamber as recited in claim 7, wherein the each of the inner and outer inductive coils is coupled to a separate RF power supply.

9. A plasma processing chamber as recited in claim 8, wherein a region is defined between the outer inductive coil and the conductive ring with inductive power that is separate from a region defined with inductive power between the inner inductive coil and the bottom electrode.

10. A plasma processing chamber as recited in claim 7, further comprising:

(e) a plurality of confinement rings disposed in the processing chamber adjacent to a region between the conductive ring and the outer inductive coil.

11. A plasma processing chamber as recited in claim 7, wherein the top capacitive electrode is coupled to ground and the bottom electrode is coupled to RF power.

12. A plasma processing chamber as recited in claim 7, wherein an RF power source is coupled to either the top capacitive electrode or the bottom electrode.

13. A plasma processing chamber as recited in claim 7, wherein both the inner and the outer inductive coils are below a chamber cover and buried in a dielectric material encircled by a conductive block, and wherein a Faraday shield is disposed beneath the dielectric material, and wherein the conductive block makes electrical contact with the Faraday shield to provide a grounding path to RF power from any of the electrodes.
14. A plasma processing chamber for capacitive coupled substrate processing and inductive coil cleaning of the plasma processing chamber, comprising:
- (a) a top electrode assembly including,
 - (i) a top capacitive electrode; and
 - (ii) an inner inductive coil and an outer inductive coil;
 - (b) a bottom electrode disposed under the top capacitive electrode;
 - (c) a dielectric ring surrounding the bottom electrode;
 - (d) a conductive ring, being coupled to ground, surrounds the bottom electrode, such that the dielectric ring is disposed between the conductive ring and the bottom electrode, the inner inductive coil is disposed over the bottom electrode and the outer inductive coil is disposed over the conductive ring; and
 - (e) one or more confinement rings disposed in the processing chamber adjacent to a region between the conductive ring and the outer inductive coil.
15. A plasma processing chamber as recited in claim 14, wherein the top capacitive electrode is coupled to ground and the bottom electrode is coupled to RF power.
16. A plasma processing chamber as recited in claim 14, wherein an RF power source is coupled to either the top capacitive electrode or the bottom electrode.
17. A plasma processing chamber as recited in claim 14, wherein both the inner and the outer inductive coils are below a chamber cover and buried in a dielectric material encircled by a conductive block, and wherein a Faraday shield is disposed beneath the dielectric material, and wherein the conductive block makes electrical contact with the Faraday shield to provide a grounding path to RF power coming from any of the electrodes.