What is claimed is:

Claims

1. A plasma processing chamber, comprising:

a substrate support configured to receive a substrate; and

an annular ring having a plurality of gas channels defined therein, the annular ring proximate to an outer edge of the substrate support and the annular ring is coupled to the substrate support, the plurality of gas channels being connected to an edge gas plenum surrounding the substrate support, the edge gas plenum being connected to a central gas plenum disposed within and near the center of the substrate support through a plurality of gas supply channels.

2. The plasma processing chamber of claim 1, wherein the plurality of gas channels are cylindrical and the diameters of the plurality of gas channels are between about 0.3 mm to about 5 mm.

3. The plasma processing chamber of claim 1, wherein each of the plurality of gas channels is pointed toward the center of the substrate at an angle between about 0 degree to about 60 degree from a vertical axis of the each of the plurality of gas channels.

4. The plasma processing chamber of claim 1, wherein there are at least 12 gas channels.

5. The plasma processing chamber of claim 1, wherein there are at least 6 gas supply channels.

6. The plasma processing chamber of claim 1, wherein the plurality of gas channels are configured to direct a process tuning gas to be carried to a region above a surface of an edge of the substrate.

7. The plasma processing chamber of claim 1, wherein the processing tuning gas includes at least one processing gas.

8. The plasma processing chamber of claim 1, wherein the plurality of gas channels are configured to direct an inert gas to be carried to an exposed region below an edge of the substrate.

9. A tuning gas assembly for a plasma processing system, comprising:

an annular ring having a plurality of tuning gas channels defined therein, the annular ring approximate to an outer edge of the substrate support and the annular ring is coupled to a substrate support in the plasma processing system, wherein the plurality of tuning gas channels supply a tuning gas approximate to an edge of the substrate support;

an edge tuning gas plenum, wherein the plurality of tuning gas channels are connected to the edge gas plenum surrounding the substrate support; and

a central tuning gas plenum disposed within and near the center of the substrate support through a plurality of tuning gas supply channels.

10. The tuning gas assembly of claim 9, wherein the plurality of tuning gas channels are cylindrical and the diameters of the plurality of tuning gas channels are between about 0.3 mm to about 5 mm.

11. The tuning gas assembly of claim 9, wherein each of the plurality of tuning gas channels is pointed toward the center of the substrate at an angle between about 0 degree to about 60 degree from a vertical axis of the each of the plurality of tuning gas channels.

12. The tuning gas assembly of claim 9, wherein there are at least 12 tuning gas channels.

13. The tuning gas assembly of claim 9, wherein there are at least 6 tuning gas supply channels.

14. The tuning gas assembly of claim 9, wherein the plurality of tuning gas channels are configured to direct a process tuning gas to be carried to a region above a surface of an edge of a substrate supported by the substrate support.

15. The plasma processing chamber of claim 9, wherein the plurality of tuning gas channels are configured to direct an inert gas to be carried to an exposed region below an edge of a substrate supported by the substrate support.

16. The plasma processing chamber of claim 10, wherein the plurality of tuning gas injection holes are configured to direct the tuning gas to be carried to an exposed region at the edge of the substrate and right below the edge of the substrate.

17. A method of improving plasma uniformity at an edge of a substrate in a plasma processing chamber, comprising method operations of:

supplying a process gas from a gas distribution plate disposed above a substrate support;

contemporarily with supplying the processing gas, introducing a tuning gas containing at least one component of the processing gas from a bottom region of the plasma processing chamber towards an outer edge of the substrate, wherein the tuning gas is supplied by a central gas plenum disposed within the substrate support; and

generating plasma by powering at least one electrode in the process chamber.

18. The method of claim 17, wherein the tuning gas increases the plasma density at the end of the substrate.

What is claimed is:

1. A plasma processing chamber, comprising:

a substrate support having a substrate support top surface configured to receive a substrate, the substrate support including an annular edge ring, the annular edge ring having a top surface substantially even with the substrate support top surface;

a main process gas feed for supplying a process gas, wherein the main process gas feed is located above the substrate support; and

a plurality of tuning gas injection channels defined within the annular edge ring, wherein the plurality of tuning gas injection channels supply a process tuning gas at an outer edge of the substrate support top surface to improve process uniformity at the edge of the substrate, wherein each of the plurality of tuning gas injection channels is pointed toward the center of the substrate oriented at an angle between about 0 degree to about 60 degrees from a vertical axis of the each of the plurality of tuning gas injection channels, the vertical axis being perpendicular to the substrate support top surface, the annular edge ring being proximate to an outer edge of the substrate support and the annular edge ring being coupled to the substrate support, and wherein the plurality of tuning gas injection channels are connected to an edge tuning gas plenum surrounding the substrate support, and wherein the edge tuning gas plenum is connected to a central tuning gas plenum through a plurality of tuning gas supply channels, the central tuning gas plenum being disposed below the substrate and within the substrate support and near-a center of the substrate support, and wherein the plurality of tuning gas supply channels are arranged evenly distributed around a circumference of the central tuning gas plenum in a spoke pattern.

2. The plasma processing chamber of claim 1, wherein the plurality of tuning gas injection channels are cylindrical and the diameters of the plurality of gas channels are between about 0.3 mm to about 5 mm.

3. The plasma processing chamber of claim 1, wherein there are at least 12 tuning gas supply channels.

4. The plasma processing chamber of claim 1, wherein there are at least 6 tuning gas supply channels.

5. The plasma processing chamber of claim 1, wherein the plurality of tuning gas injection channels are configured to direct a process tuning gas to be carried to a region above a surface of the edge of the substrate.

6. The plasma processing chamber of claim 1, wherein the process tuning gas includes at least one processing gas.

7. The plasma processing chamber of claim 1, wherein the plurality of tuning gas injection channels are configured to direct an inert gas to be carried to an exposed region below the edge of the substrate.

8. A tuning gas assembly for a plasma processing system, comprising:

a plurality of tuning gas injection channels defined within an annular edge ring, the annular edge ring being proximate to an outer edge of a substrate support, the annular edge ring having a top surface substantially even with a substrate support top surface and the annular edge ring being coupled to the substrate support in the plasma processing system, wherein the plurality of tuning gas injection channels supply a process tuning gas in addition to a process gas supplied by a main process gas feed, wherein the process tuning gas is supplied proximate to an edge of the substrate support top surface to improve process uniformity at an edge of the substrate, wherein each of the plurality of tuning gas injection channels is pointed toward the center of the substrate

oriented at an angle between about 0 degree to about 60 degrees from a vertical axis of the each of the plurality of tuning gas injection channels, the vertical axis being perpendicular to the substrate support top surface;

an edge tuning gas plenum, wherein the plurality of tuning gas injection channels are connected to the edge tuning gas plenum surrounding the substrate support;

a central tuning gas plenum disposed within and near a center of the substrate support and below the substrate; and

a plurality of tuning gas supply channels, wherein the edge tuning gas plenum is connected to the central tuning gas plenum through the plurality of tuning gas supply channels, and wherein the plurality of tuning gas supply channels are arranged evenly distributed around a circumference of the central tuning gas plenum in a spoke pattern.

9. The tuning gas assembly of claim 8, wherein the plurality of tuning gas injection channels are cylindrical and the diameters of the plurality of tuning gas injection channels are between about 0.3 mm to about 5 mm.

10. The tuning gas assembly of claim 8, wherein there are at least 12 tuning gas supply channels.

11. The tuning gas assembly of claim 8, wherein there are at least 6 tuning gas supply channels.

12. The tuning gas assembly of claim 1, wherein the plurality of tuning gas injection channels are configured to direct a process tuning gas to be carried to a region above a surface of the edge of a substrate supported by the substrate support.

13. The plasma processing chamber of claim 1, wherein the plurality of tuning gas injection channels are configured to direct an inert gas to be carried to an exposed region

below the edge of a substrate supported by the substrate support.

14. The plasma processing chamber of claim 9, wherein the plurality of tuning gas injection channels are configured to direct the tuning gas to be carried to an exposed region at the edge of the substrate and right below the edge of the substrate.

15. A plasma processing chamber, comprising: a chamber top; a chamber bottom; a plurality of chamber walls; each of the plurality of chamber walls connected to at least two other chamber walls, the chamber top and the chamber bottom; a first gas feed coupled to a first gas source, wherein the first gas feed is disposed in the chamber top; and a substrate support disposed on the chamber bottom, the substrate support including: a substrate support top surface configured to receive a substrate; an annular edge ring, the annular edge ring having: an annular edge ring top surface substantially parallel with the substrate support top surface and proximate to a perimeter of a received substrate; and a plurality of gas injection channels within the annular edge ring, each of the plurality of gas injection channels having a corresponding input coupled to a second gas source and a corresponding outlet terminating in a corresponding one of a plurality of gas injection ports in the annular edge ring top surface, the plurality of gas injection ports being proximate to and substantially evenly spaced around the perimeter of the received substrate, wherein each of the plurality of gas injection channels is oriented at an angle of between about 0 degrees to about 60 degrees from a vertical axis perpendicular to the substrate support top surface, wherein the at least one gas plenum input includes a plurality of gas plenum inputs coupled to a central tuning gas plenum through a plurality of tuning gas supply channels, the central tuning gas plenum being disposed within the substrate support and near a center of the substrate support, and wherein the plurality of tuning gas supply channels are arranged substantially evenly distributed around a circumference of the central tuning gas plenum in a spoke pattern.

16. The plasma processing chamber of claim 15, wherein each of the plurality of gas injection channels having corresponding inputs coupled to the second gas source includes a gas plenum having at least one gas plenum input coupled to the second gas source and a plurality of gas plenum outputs coupled to the corresponding inputs of the plurality of gas injection channels.

17. The plasma processing chamber of claim 16, wherein the gas plenum is an annular gas plenum included in the annular edge ring.