

manometers 1510, and thermocouples located in delivery system, the pedestal or chuck (e.g. the temperature sensors 1514). Appropriately programmed feedback and control algorithms may be used with data from these sensors to maintain desired process conditions. The foregoing describes implementation of embodiments of the invention in a single or multi-chamber semiconductor processing tool.

[00101] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the invention, and all such modifications are intended to be included within the scope of the invention.

[00102] Although the foregoing embodiments have been described in some detail for purposes of clarity of understanding, it will be apparent that certain changes and modifications can be practiced within the scope of the appended claims. Accordingly, the present embodiments are to be considered as illustrative and not restrictive, and the embodiments are not to be limited to the details given herein, but may be modified within their scope and equivalents of the claims.

CLAIMS

1. An edge ring assembly for a plasma processing chamber, comprising:
an upper edge ring configured to surround an electrostatic chuck (ESC) that is
5 configured for electrical connection to an RF power supply, the ESC having a top surface for supporting a substrate and an annular step surrounding the top surface, the annular step defining an annular shelf that is lower than the top surface, the upper edge ring being disposed above the annular shelf, the upper edge ring being defined from an electrically insulating material;
10 a lower inner edge ring disposed below the upper edge ring in the annular step and disposed on the annular shelf, the lower inner edge ring being defined from an electrically conductive material, the lower inner edge ring being electrically insulated from the ESC;
a lower outer edge ring surrounding the inner edge ring, the lower outer edge ring being disposed below the upper edge ring in the annular step and disposed over the annular
15 shelf, the lower outer edge ring being defined from an electrically insulating material.
2. The edge ring assembly of claim 1, wherein a dielectric separation between the lower inner edge ring and the ESC is configured to provide for a predefined capacitance, wherein power transferred to the ESC from the RF power supply is transferred to the lower
20 inner edge ring in a predefined relative amount as determined by the predefined capacitance.
3. The edge ring assembly of claim 1, wherein the upper edge ring is defined from a quartz material.

4. The edge ring assembly of claim 1, wherein the lower outer edge ring is defined from a quartz material.

5. The edge ring assembly of claim 1, wherein the lower inner edge ring is defined
5 from an aluminum material.

6. The edge ring assembly of claim 1, wherein the lower inner edge ring has an anodized aluminum surface that provides for the electrical insulation from the ESC, or wherein the lower inner edge ring and the lower outer edge ring are disposed directly over the
10 annular shelf of the ESC.

7. The edge ring assembly of claim 1, wherein the lower inner edge ring is electrically insulated from the ESC so that, in use, it provides for a capacitive coupling of the lower inner edge ring to the ESC during application of RF power from the RF power supply to the ESC
15 during plasma processing.

8. The edge ring assembly of claim 1, wherein in use the capacitive coupling during plasma processing causes a plasma sheath that is defined during the plasma processing to be radially extended in a spatial region that is defined substantially over the upper edge ring.
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9. The edge ring assembly of claim 8, wherein in use the capacitive coupling during plasma processing reduces ion focusing at an edge region of the substrate.

10. The edge ring assembly of claim 9, wherein in use the capacitive coupling during plasma processing reduces tilting of ion trajectories at the edge region of the substrate away from normal to a top surface of the substrate.

5 11. The edge ring assembly of claim 1, wherein the upper edge ring is annularly shaped, having a radial thickness of about 15 to 24 mm, and a height of about 2mm to 5mm.

12. The edge ring assembly of claim 1, wherein the lower inner edge ring is annularly shaped, having a radial thickness of about 15 to 20 mm, and a height of about 8 to
10 15mm.

13. The edge ring assembly of claim 12, wherein an inner diameter of the lower inner edge ring is about 0.5 to 1 mm greater than a diameter of a sidewall defined by the annular step of the ESC, so as to define an annular gap between the sidewall and the lower
15 inner edge ring.

14. The edge ring assembly of claim 1, wherein the lower outer edge ring is annularly shaped, having a radial thickness of about 10 to 15 mm, and a height of about 8mm to 15mm, or wherein the upper edge ring has a top surface, the top surface of the upper edge
20 ring having a stepped edge defined at an inner diameter of the upper edge ring, wherein a lower portion of the stepped edge is configured to sit at a lower height than the top surface of the ESC, such that the substrate when present extends over the lower portion of the stepped edge, or wherein the lower inner edge ring includes a yttria outer coating.

25 15. A system for plasma processing, comprising:

a process chamber;

an electrostatic chuck (ESC) disposed in the process chamber, the ESC having a top surface that is configured to support a substrate during plasma processing, the ESC further including an annular step surrounding the top surface, the annular step defining an annular

5 shelf at a lower height than the top surface;

an edge ring assembly according to any claims 1-14;

a bias electrode disposed within the ESC, the bias electrode configured to receive RF power from a first RF power supply to generate a bias voltage on the substrate.