Claims:

1. A showerhead electrode for a showerhead electrode assembly in a parallel plate capacitively coupled plasma processing chamber, the showerhead electrode assembly comprising a backing plate having gas injection holes extending between upper and lower faces thereof, a plurality of stud/socket assemblies and cam shafts, an alignment ring, and a plurality of alignment pins; the showerhead electrode comprising:

a plasma exposed surface on a lower face thereof;

a mounting surface on an upper face thereof;

a plurality of gas injection holes extending between the plasma exposed surface and the mounting surface thereof and arranged in a pattern matching the gas injection holes in the backing plate;

wherein the gas injection holes have a diameter less than or equal to 0.04 inch (0.001 m) and are arranged in a pattern with one center gas injection hole at a center of the electrode and eight concentric rows of gas injection holes,

the first row having seven gas injection holes located at a radial distance of about 0.6-0.7 inch (0.015-0.018 m) from the center of the electrode;

the second row having seventeen gas injection holes located at a radial distance of about 1.3-1.4 inches (0.033-0.036 m) from the center of the electrode;

the third row having twenty-eight gas injection holes located at a radial distance of about 2.1-2.2 inches (0.053-0.056 m) from the center of the electrode;

the fourth row having forty gas injection holes located at a radial distance of about 2.8-3.0 inches (0.071-0.076 m) from the center of the electrode;

the fifth row having forty-eight gas injection holes located at a radial distance of about 3.6-3.7 inches (0.091-0.094 m) from the center of the electrode;

the sixth row having fifty-six gas injection holes located at a radial distance of about 4.4-4.5 inches (0.112-0.114 m) from the center of the electrode;

the seventh row having sixty-four gas injection holes located at a radial distance of about 5.0-5.1 inches (0.127-0.130 m) from the center of the electrode;

the eighth row having seventy- two gas injection holes located at a radial distance of about 5.7-5.8 inches (0.145-0.147 m) from the center of the electrode;

the gas injection holes in each row are azimuthally equally spaced;

wherein the showerhead electrode is an inner electrode of a showerhead electrode assembly comprising an outer electrode having an inner flange and threaded sockets configured to receive stud/socket assemblies which engage openings in the lower face of the backing plate, an annular shroud having a plurality of threaded sockets configured to

receive stud/socket assemblies which engage openings in the lower face of the backing plate, the inner electrode comprising:

a single annular step on an outer periphery thereof, the single annular step configured to mate with the inner flange of the outer electrode;

a plurality of unthreaded blind holes in the mounting surface configured to receive the alignment pins;

an annular groove in the mounting surface configured to receive the alignment ring; and

a plurality of threaded sockets in the mounting surface configured to receive the stud/socket assemblies which engage the cam shafts and attach the inner electrode to the backing plate without using a clamp ring; and

wherein the threaded sockets comprise eight threaded sockets in a first circular row located on a radius of 1/4 to 1/2 the radius of the inner electrode and eight threaded sockets in a second circular row located on a radius greater than 1/2 the radius of the inner electrode.

2. The showerhead electrode of claim 1, wherein each of the threaded sockets is threaded to a thread size of 7/16-28 (0.011 m) and has a threaded depth of at least 0.163 inch (0.004 m); the first circular row located at a radial distance of about 2.4-2.6 inches (0.061-0.066 m) from the center of the inner electrode; and the second circular row located at a radial distance of about 5.3-5.5 inches (0.135-0.140 m) from the center of the inner electrode.

3. The showerhead electrode of claim 1, wherein the plurality of unthreaded blind holes configured to receive the alignment pins comprises a first set of holes and a second set of holes;

the first set of holes comprising two holes: (a) located at a radial distance of about 1.7-1.8 inches (0.043-0.046 m) from the center of the inner electrode; (b) azimuthally offset by about 175° from each other; (c) having a diameter of about 0.10-0.12 inch (0.002-0.003 m); and (d) having a depth of at least 0.2 inch (0.005 m);

the second set of holes comprising a first hole, a second hole and a third hole: (a) located at a radial distance of about 6.0-6.1 inches (0.152-0.155 m) from the center of the inner electrode; (b) the first hole azimuthally offset by about 10° clockwise from one hole in the first set; (c) the second and third holes azimuthally offset by about 92.5° and about 190° counterclockwise from the first hole; (d) having a diameter of about 0.11-0.12 inch (0.0028-0.0030 m); and (e) having a depth of at least 0.1 inch (0.003 m).

4. The showerhead electrode of claim 1, wherein:

the inner electrode is a planar disk having a uniform thickness of about 0.4 inch (0.010 m) and a diameter about 12.5 inches (0.318 m); the annular step has an inner diameter of about 12.0 inches (0.305 m) and a vertical surface about 0.2 inch (0.005 m) long; the annular groove has an outer diameter of about 0.44 inch (0.011 m), an inner diameter of about 0.24 inch (0.006 m) and a depth of at least 0.1 inch (0.003 m); the inner electrode is manufactured from a plate of single crystal silicon or polycrystalline silicon with a resistivity between 0.005 and 0.020 Ohm-cm and a total heavy metal contamination less than 10 parts per million.

5. A showerhead electrode assembly comprising the inner electrode of claim 1, further comprising:

a stud/socket assembly threaded into each threaded socket of the inner electrode; and

a backing plate having bores with cam shafts mounted therein;

wherein the showerhead electrode is fastened to the backing plate solely by the stud/socket assemblies engaged with the cam shafts.

6. The showerhead electrode assembly of claim 5, wherein two of stud/socket assemblies threaded in the threaded sockets of the showerhead electrode engage with a single cam shaft.

7. A showerhead electrode assembly comprising the inner electrode of claim 1, further comprising:

a stud/socket assembly threaded into each threaded socket of the outer electrode, the outer electrode including an outer flange and the inner flange, the inner flange overlying the annular step of the inner electrode; and

a stud/socket assembly threaded into each threaded socket of the annular shroud, the annular shroud having an inner flange overlying the outer flange of the outer electrode;

wherein the outer electrode and the annular shroud are fastened to the backing plate by the stud/socket assemblies engaged with the cam shafts.

8. The showerhead electrode assembly of claim 7, wherein a stud/socket assembly threaded in a threaded socket of the outer electrode and a stud/socket assembly threaded in a threaded socket of the annular shroud engage with a single cam shaft.

9. A method of assembling the showerhead electrode assembly of claim 7, comprising:

inserting an alignment ring into the annular groove on the mounting surface of the inner electrode;

inserting alignment pins into the plurality of unthreaded blind holes on the mounting surface of the inner electrode;

mounting an inner gasket on the mounting surface of the inner electrode; fastening the inner electrode with the inner gasket mounted thereon to the backing plate with cam locks;

placing a first annular gasket on the upper surface of the outer electrode; placing a second annular gasket on the annular shroud;

fastening the outer electrode with the first annular gasket mounted thereon and the annular shroud with the second annular gasket mounted thereon to the backing plate with cam locks.

10. ~~A thermally and electrically conductive gasket of a gasket set configured to be mounted in a~~ The showerhead electrode assembly of claim 5 comprising a thermally and electrically conductive gasket of a gasket set,

the gasket set consisting of:

an inner gasket configured to be mounted on the inner electrode, comprising a plurality of concentric flat rings connected by a plurality of spokes;

a first annular gasket ~~configured to~~ surrounding and being concentric with the inner gasket and being mounted on the outer electrode, comprising a flat annular ring having a plurality of cutouts;

a second annular gasket ~~configured to~~ surrounding and being concentric with the first annular gasket and being mounted on the annular shroud, comprising a flat annular ring having a plurality of cutouts;

wherein the gasket set accommodates gas injection holes, alignment pin holes, the alignment ring groove and/or the threaded sockets.

11. The showerhead electrode assembly ~~gasket~~ of claim ~~10~~5, wherein the concentric flat rings in the inner gasket are continuous or segmented.

12. The showerhead electrode assembly ~~gasket~~ of claim ~~10~~5, wherein the inner gasket comprises at least six concentric flat rings having a thickness of about 0.006 inch (0.0002 m) and a width of at least 0.1 inch (0.003 m), wherein the first ring has an inner diameter of at least 0.44 inch (0.011 m) and an outer diameter of at most 1.35 inches (0.034 m); the second ring has an inner diameter of at least 1.35 inches (0.034 m) and an outer

diameter of at most 2.68 inches (0.068 m); the third ring has an inner diameter of at least 2.68 inches (0.068 m) and an outer diameter of at most 4.23 inches (0.107 m); the fourth ring has an inner diameter of at least 4.23 inches (0.107 m) and an outer diameter of at most 5.79 inches (0.147 m); the fifth ring has an inner diameter of at least 5.79 inches (0.147 m) and an outer diameter of at most 7.34 inches (0.186 m); the sixth ring has an inner diameter of at least 7.34 inches (0.186 m) and an outer diameter of at most 8.89 inches (0.226 m).

13. The showerhead electrode assembly ~~gasket~~ of claim ~~12~~5, wherein the inner gasket comprises nine concentric flat rings, wherein the seventh ring has an inner diameter of at least 8.89 inches (0.226 m) and an outer diameter of at most 10.18 inches (0.259 m); the eighth ring has an inner diameter of at least 10.18 inches (0.259 m) and an outer diameter of at most 1-1.46 inches (0.025-0.037 m); the ninth ring has an inner diameter between 11.92 and 11.97 inches (0.303 and 0.304 m) and an outer diameter between 12.45 and 12.50 inches (0.316 and 0.318 m).

14. The showerhead electrode assembly ~~gasket~~ of claim ~~10~~5, wherein:

(a) the first annular gasket has one cutout on an inner perimeter and a first set of eight holes configured to accommodate stud/socket assemblies and a second set of three holes configured to allow tool access wherein the diameter of the holes in the first set is larger than the diameter of the holes in the second set; and

(b) the second annular gasket has eight cutouts on an outer perimeter configured to accommodate stud/socket assemblies and no cutouts on an inner perimeter.

15. The showerhead electrode assembly ~~gasket~~ of claim ~~10~~5, wherein:

(a) the first annular gasket has a thickness of about 0.006 inch (0.0002 m), a width of about 1.3 inch (0.033 m), an inner diameter of about 14.06 inches (0.357 m) and an outer diameter of about 16.75 inches (0.425 m); and

(b) the second annular gasket has a thickness of about 0.006 inch (0.0002 m), a width of about 0.7 inch (0.018 m), an inner diameter of 17.29 inches (0.439 m) and an outer diameter of about 18.69 inches (0.475 m).