CLAIMS

1. A plasma reactor for processing a workpiece comprising:

a chamber having a dielectric window;

a workpiece support to hold a workpiece in the chamber;

a rotary coupling comprising a stationary stage configured to be coupled to a microwave source and a rotatable stage having an axis of rotation;

a microwave antenna overlying the dielectric window of the chamber, the microwave antenna including at least one conduit coupled to the rotatable stage;

a rotary actuator to rotate the microwave antenna;

a process gas supply; and

a process gas distributor including a gas distribution ring surrounding the workpiece support, the gas distribution ring including a cylindrical chamber liner, the cylindrical chamber liner forming a portion of a chamber wall separated from the workpiece support by a gap and separating a circular conduit from the chamber, the gas distribution ring including a plurality of apertures extending radially through the cylindrical chamber liner to connect the circular conduit to the chamber, wherein

the circular conduit comprises a first arc coupled to the process gas supply, a second arc coupled to a vacuum pump, and a barrier preventing direct fluid flow between the first arc and second arc such that process gas flows through the first arc into the chamber and out of the chamber through the second arc, and wherein

the plurality of the apertures are positioned in the cylindrical chamber liner radially outward of the workpiece support and open into the chamber below a plane defined by a top surface of the workpiece support.

2. The plasma reactor of claim 1, wherein the plurality of apertures are distributed with uniform angular spacing around the cylindrical chamber liner.

3. The plasma reactor of claim 1, wherein the first arc and the second arc have substantially the same arc length.

4. The plasma reactor of claim 1, comprising a gas distribution plate on a ceiling of the chamber.

5. The plasma reactor of claim 4, wherein the dielectric window provides the gas distribution plate.

6. The plasma reactor of claim 1, wherein the gas distribution ring has between six and one-hundred apertures.