[0008] In FIG. 2, after the edge ring 30 has been used, an upper surface of a radially inner portion of the edge ring 30 may exhibit erosion as identified at 48. As a result, plasma 42 may tend to etch a radially outer edge of the substrate 33 at a faster rate than etching of radially inner portions thereof as can be seen at 44.

[0009] Coatings have been used to improve erosion resistance of the edge ring and other components in the processing chamber. For example, a diamond-like carbon coating has been tested. However, the coating was etched very quickly by oxygen plasma. The semiconductor fabrication equipment industry has pursued other approaches for reducing edge ring erosion due to the high etch rate of diamond-like carbon coatings.

SUMMARY

[0010] A pedestal for a plasma processing system includes a substrate supporting surface. An annular edge ring is arranged around a periphery of the substrate supporting surface. A diamond coating is arranged on a plasma-exposed surface of the annular edge ring. The diamond coating includes sp3 bonds. A purity of the sp3 bonds in the diamond coating is greater than 90%.

[0011] In other features, the purity of the sp3 bonds in the diamond coating is greater than 95%. The purity of the sp3 bonds in the diamond coating is greater than 99%. The diamond coating is deposited on the annular edge ring using chemical vapor deposition (CVD).

[0012] A plasma processing system includes a processing chamber. The pedestal is arranged in the processing chamber. A plasma source creates plasma in the

of the pedestal 232 are coated with the diamond coating d. In some examples, the pedestal 232 includes an edge ring (not shown) that is coated with the diamond coating as described above. The pedestal 232 may include an electrostatic chuck, a mechanical chuck or other type of chuck. Plasma 240 is generated inside of the processing chamber 228. The plasma 240 etches an exposed surface of the substrate 234. An RF source 250 and a bias matching circuit 252 may be used to bias the pedestal 232 during operation.

[0043] A gas delivery system 256 may be used to supply a gas mixture to the processing chamber 228. The gas delivery system 256 may include process gas sources 257, a metering system 258 such as valves and mass flow controllers, and a manifold 259. A heater 264 may be used to heat the pedestal 232 to a predetermined temperature. An exhaust system 265 includes a valve 266 and pump 267 to remove reactants from the processing chamber 228 by purging or evacuation.

[0044] A controller 254 may be used to control the etching process. The controller 254 monitors system parameters and controls delivery of the gas mixture, striking, maintaining and extinguishing the plasma, removal of reactants, supply of cooling gas, etc.

[0045] Referring now to FIG. 6, a substrate processing chamber 300 for etching or ashing a substrate according to the present disclosure is shown. Various components in the substrate processing chamber 300 may be coated with the diamond coating d as described above. While a specific type of substrate processing chamber is shown and described, the improvements described herein may be applied to a variety of other substrate processing chambers.

325. In some examples, gas through holes 331 in the gas distribution device 314 align with the gas flow channels 327. In other examples, the gas distribution device 314 has a smaller diameter and the gas through holes 331 are not needed. In some examples, the process gas is delivered by the one or more gas flow channels 327 in a downward direction towards the substrate at an acute angle relative to the plane including the gas distribution device 314, although other angles/directions may be used.

[0049] In other examples, the upper chamber region 304 is cylindrical with a flat top surface and a flat inductive coil may be used. In still other examples, a single chamber may be used with a spacer located between a showerhead and the pedestal.

[0050] A pedestal 322 is arranged in the lower chamber region 302. In some examples, the pedestal 322 includes an electrostatic chuck (ESC), although other types of pedestals can be used. A substrate 326 is arranged on an upper surface of the pedestal 322 during etching. In some examples, one or more surfaces of the pedestal are coated with the diamond coating. In some examples, a temperature of the substrate 326 may be controlled by a heater plate, an optional cooling plate with fluid channels and one or more sensors (all not shown); although any other suitable pedestal temperature control system may be used.

[0051] In some examples, the gas distribution device 314 includes a showerhead (for example, a plate 328 having a plurality of through holes 329). The plurality of through holes 329 extend from the upper surface of the plate 328 to the lower surface of the plate 328. In some examples, the through holes 329 have a diameter in a range from 0.4” to 0.75” and the showerhead is made of a conducting material such as aluminum or

CLAIMS

1. A pedestal for a plasma processing system, comprising:

a substrate supporting surface;

an annular edge ring arranged around a periphery of the substrate supporting surface; and

a diamond coating arranged on a plasma-exposed surface of the annular edge ring,

wherein the diamond coating includes sp3 bonds, and

wherein a purity of the sp3 bonds in the diamond coating is greater than 90%.

2. The pedestal of claim 1, wherein the purity of the sp3 bonds in the diamond coating is greater than 95%.

3. The pedestal of claim 1, wherein the purity of the sp3 bonds in the diamond coating is greater than 99%.

4. The pedestal of claim 1, wherein the diamond coating is deposited on the annular edge ring using chemical vapor deposition (CVD).

5. A plasma processing system comprising:

a processing chamber, wherein the pedestal of claim 1 is arranged in the processing chamber; and

a plasma source to create plasma in the processing chamber.