

CLAIMS

1. A substrate processing system, comprising:

a processing chamber, comprising a chamber lid assembly, one or more chamber sidewalls, and a chamber base that collectively define a processing volume;
a gas delivery system fluidly coupled to the processing chamber, the gas delivery system comprising a first radical generator and a second radical generator;
and

a non-transitory computer-readable medium having instructions stored thereon for performing a method of processing a plurality of substrates when executed by a processor, the method comprising:

- (a) receiving a substrate into the processing volume;
- (b) exposing the substrate to an activated treatment gas, the activated treatment gas comprising an effluent of a treatment plasma formed in the first radical generator;
- (c) exposing the substrate to a first tungsten-containing precursor and a first reducing agent to deposit a tungsten gapfill material;
- (d) transferring the substrate out of the processing volume;
- (e) repeating (a)-(d) when a number of sequentially processed substrates is less than or equal to a threshold value;
- (f) exposing chamber surfaces in the processing volume to an activated cleaning gas when the number of sequentially processed substrates is greater than the threshold value, the activated cleaning gas comprising an effluent of a cleaning plasma formed in the second radical generator; and
- (g) repeating (a)-(f).

2. The processing system of claim 1, wherein the method further comprises:

after (a) and before (b), depositing a tungsten nucleation layer comprising exposing the substrate to the first tungsten-containing precursor or a second tungsten-containing precursor and the first reducing agent or a second reducing agent to deposit a tungsten nucleation layer.

3. The processing system of claim 2, wherein

the substrate comprises a material layer having a plurality of openings formed therein, and

exposing the substrate to the activated treatment gas differentially inhibits tungsten deposition on a field surface of the substrate relative to surfaces within the plurality of openings.

4. The processing system of claim 2, wherein depositing the tungsten nucleation layer comprises repeating cycles of alternately exposing the substrate to the second tungsten-containing precursor and the second reducing agent.

5. The processing system of claim 4, wherein depositing the tungsten gapfill material comprises repeating cycles of alternately exposing the substrate to the first tungsten-containing precursor and the first reducing agent.

6. The processing system of claim 4, wherein depositing the tungsten gapfill material comprises heating the substrate to a temperature of 250 °C or more and concurrently flowing the first tungsten-containing precursor and the first reducing agent into the processing volume.

7. The processing system of claim 1, wherein the gas delivery system further comprises:

a first valve fluidly coupled between the first radical generator and the processing chamber; and

a second valve fluidly coupled between the second radical generator and the processing chamber,

wherein exposing the chamber surfaces to the activated cleaning gas comprises fluidly isolating the first radical generator from the effluent of the cleaning plasma by use of the first valve.

8. The processing system of claim 7, wherein exposing the substrate to the activated treatment gas comprises fluidly isolating the second radical generator from the effluent of the treatment plasma by use of the second valve.

9. The processing system of claim 7, wherein the lid assembly comprises a lid plate and a showerhead coupled to the lid plate, and the first and second radical generators are disposed in fluid communication with the processing volume through a gas inlet formed through the lid plate.

10. The processing system of claim 9, wherein the effluent of the treatment plasma travels a first distance from the first radical generator to the processing volume and the effluent of the cleaning plasma travels a second distance from the second radical generator to the processing volume, and the first distance is less than the second distance.

11. A method of processing a substrate, comprising:

(a) receiving a substrate into a processing volume of a processing system, the processing system comprising:

a processing chamber comprising a chamber lid assembly, one or more chamber sidewalls, and a chamber base that collectively define the processing volume; and

a gas delivery system fluidly coupled to the processing chamber, the gas delivery system comprising a first radical generator and a second radical generator;

(b) exposing the substrate to an activated treatment gas, the activated treatment gas comprising an effluent of a treatment plasma formed in the first radical generator;

(c) exposing the substrate to a first tungsten-containing precursor and a first reducing agent;

(d) transferring the substrate out of the processing volume;

(e) repeating (a)-(d) when a number of sequentially processed substrates is less than or equal to a threshold value;

(f) exposing chamber surfaces in the processing volume to an activated cleaning gas when the number of sequentially processed substrates is greater than the threshold value, the activated cleaning gas comprising an effluent of a cleaning plasma formed in the second radical generator; and

(g) repeating (a)-(f).

12. The method of claim 11, wherein exposing the substrate to the effluent of the treatment plasma comprises maintaining the processing volume at a pressure of 50 Torr or less.
13. The method of claim 11, further comprising:
after (a) and before (b), depositing a tungsten nucleation layer comprising exposing the substrate to the first tungsten-containing precursor or a second tungsten-containing precursor and the first reducing agent or a second reducing agent to deposit a tungsten nucleation layer.
14. The method of claim 13, wherein
the substrate comprises a material layer having a plurality of openings formed therein, and
exposing the substrate to the activated treatment gas differentially inhibits tungsten deposition on a field surface of the substrate relative to surfaces within the plurality of openings.
15. The method of claim 11, wherein the gas delivery system further comprises:
a first valve fluidly coupled between the first radical generator and the processing chamber; and
a second valve fluidly coupled between the second radical generator and the processing chamber,
wherein exposing the chamber surfaces to the activated cleaning gas comprises fluidly isolating the first radical generator from the effluent of the cleaning plasma by use of the first valve.
16. The method of claim 15, wherein exposing the substrate to the activated treatment gas comprises fluidly isolating the second radical generator from the effluent of the treatment plasma by use of the second valve.
17. The method of claim 16, wherein the lid assembly comprises a lid plate and a showerhead coupled to the lid plate, and the first and second radical generators are disposed in fluid communication with the processing volume through a gas inlet formed through the lid plate.

18. The method of claim 17,
wherein the effluent of the treatment plasma travels a first distance from the first radical generator to the processing volume;
wherein the effluent of the cleaning plasma travels a second distance from the second radical generator to the processing volume; and
wherein the first distance is less than the second distance.