CLAIMS

1. A method comprising:

providing a substrate including a feature having an opening in a top surface, a sidewall and a bottom in a chamber; and

depositing a tungsten nucleation layer in the feature by performing multiple cycles of:

flowing a boron-containing reducing agent pulse in the chamber, wherein the boron-containing reducing agent is adsorbed to the feature sidewall and feature bottom,

purging the chamber,

flowing a tungsten-containing precursor pulse in the chamber to react with the adsorbed boron-containing reducing agent, and

purging the chamber,

wherein hydrogen (H_2) is flowed during the boron-containing reducing agent pulse and no H_2 is flowed during the tungsten-containing precursor pulse, wherein H_2 suppresses thermal decomposition of the boron-containing reducing agent,

wherein the volumetric flow ratio of the H_2 to the boron-containing reducing agent is between 20:1 and 400:1.

2. The method of claim 1, wherein the tungsten nucleation layer is at least 10 Angstroms thick and step coverage throughout the feature is at least 90%, step coverage being the ratio of the thickness of the tungsten nucleation layer at any point in the feature to the thickness of the tungsten nucleation layer at the top surface.

3. The method of claim 1, wherein depositing the nucleation layer further comprises at least one cycle of flowing a silane pulse in the chamber; purging the chamber; flowing a tungsten-containing precursor pulse in the chamber; and purging the chamber, wherein no hydrogen is flowed during the tungsten-containing precursor pulse.

4. The method of claim 3, wherein no hydrogen is flowed during the silane pulse.

5. The method of claim 3, wherein hydrogen is flowed during the silane pulse.

6. The method of claim 1, wherein the tungsten nucleation layer is between 10 Angstroms and 50 Angstroms thick.

7. The method of any of the above claims, wherein the substrate temperature is below 350°C.

8. The method of any of the above claims, wherein the substrate temperature is between about 250°C and 300°C.

9. The method of any of the above claims, wherein hydrogen reacts with decomposition byproducts of the boron-containing reducing agent.

10. The method of any of the above claims, wherein the boron-containing reducing agent pulse in the chamber is flowed into the chamber with an inert carrier gas.

11. The method of any of the above claims, wherein the boron-containing reducing agent is diborane.

12. A method comprising:

providing a substrate including a feature having an opening in a top surface, a sidewall and a bottom in a chamber;

depositing a tungsten nucleation layer in the feature by performing multiple cycles of:

flowing a boron-containing reducing agent pulse in the chamber;

purging the chamber;

flowing a tungsten-containing precursor pulse in the chamber; and

purging the chamber, wherein hydrogen is flowed during the boron-containing reducing agent pulse and no hydrogen is flowed during the tungsten-containing precursor pulse,

wherein the volumetric flow ratio of the H_2 to the boron-containing reducing agent is between 20:1 and 400:1.

13. An apparatus comprising:

(a) a process chamber comprising at least one station having a pedestal configured to hold a substrate;

(b) at least one outlet for coupling to a vacuum;

(c) one or more process gas inlets coupled to one or more process gas sources; and

(d) a controller for controlling operations in the apparatus, comprising machine-readable instructions for:

flowing a boron-containing reducing agent pulse in the chamber;

purging the chamber;

flowing a tungsten-containing precursor pulse in the chamber; and

purging the chamber, wherein hydrogen is flowed during the boron-containing reducing agent pulse and no hydrogen is flowed during the tungsten-containing precursor pulse, wherein the volumetric flow ratio of the H_2 to the boron-containing reducing agent is between 20:1 and 400:1.

14. The apparatus of claim 13, wherein the controller comprises instructions for maintaining a pedestal temperature less than 350°C.

15. The apparatus of claim 13, wherein the controller comprises instructions for maintaining a pedestal temperature between 175°C to 300°C.

16. The apparatus of claim 13, wherein the controller comprises instructions for flowing a silane pulse in the chamber; purging the chamber; flowing a tungsten-containing precursor pulse in the chamber; and purging the chamber, wherein no hydrogen is flowed during the tungsten-containing precursor pulse.

17. The method of claim 12, wherein the substrate temperature is less than 350°C.

18. The method of claim 12, wherein the substrate temperature is between 175°C to 300°C.

19. The method of claim 12, further comprising instructions for flowing a silane pulse in the chamber; purging the chamber; flowing a tungsten-containing precursor pulse in the chamber; and purging the chamber, wherein no hydrogen is flowed during the tungsten-containing precursor pulse.