CLAIMS

1. A method of forming a tungsten carbide film, comprising:

forming, by plasma-enhanced chemical vapor deposition (PECVD), a tungsten carbide initiation layer directly on a silicon-containing surface of a substrate at a first deposition rate; and

forming a tungsten carbide film on the tungsten carbide initiation layer at a second deposition rate, wherein the second deposition rate is greater than the first deposition rate.

2. The method of claim 1, wherein a ratio of the second deposition rate to the first deposition rate is 3:1 or greater.

3. The method of claim 2, wherein the second deposition rate is 30 Å/second or greater and the first deposition rate is 10 Å/second or less.

4. The method of claim 3, wherein the second deposition rate is in a range of 30 Å/second to 40 Å/second and the first deposition rate is in a range of 5 Å/second to 10 Å/second.

5. The method of claim 1, wherein the tungsten carbide initiation layer has a thickness in a range of 10 Å to 200 Å.

6. The method of claim 5, wherein the tungsten carbide film has a thickness of 5,000 Å or greater.

7. The method of claim 6, wherein forming the tungsten carbide initiation layer comprises exposing the silicon-containing surface to a first reactive gas comprising WF_6,

C_3H_6, and optionally H_2 in a first PECVD process including a first RF plasma power of 00 Watts or less at a first pressure in a first range of 2 Torr to 10 Torr.

8. The method of claim 7, wherein the WF_6 and C_3H_6 in the first reactive gas are present in a ratio of 2:1 or greater.

9. The method of claim 7, wherein forming the tungsten carbide film comprises exposing the tungsten carbide initiation layer to a second reactive gas comprising WF_6, C_3H_6, and optionally H_2 in a second PECVD process including a second RF plasma power of 500 Watts or greater at a second pressure in a second range of 2 Torr to 10 Torr.

10. The method of claim 1, wherein the silicon-containing surface comprises silicon oxide, silicon nitride, or combinations thereof.

11. A method of forming a tungsten carbide film, comprising:

forming a tungsten carbide initiation layer directly on a silicon-containing surface of a substrate at a first deposition rate, comprising exposing the silicon-containing surface to a first reactive gas comprising WF_6, C_3H_6, and H_2 in a first PECVD process including a first RF plasma power of about 100 Watts or less at a first pressure in a range of 2 Torr to 10 Torr; and

forming a tungsten carbide film on the tungsten carbide initiation layer at a second deposition rate, comprising exposing the tungsten carbide initiation layer to a second reactive gas comprising WF_6, C_3H_6, and optionally H_2 in a second PECVD process including a second RF plasma power of 500 Watts or greater at a second pressure in a range of 2 Torr to 10 Torr, wherein the second deposition rate is greater than the first deposition rate.

12. The method of claim 11, wherein a ratio of the second deposition rate to the first deposition rate is 3:1 or greater.

13. The method of claim 12, wherein the second deposition rate is 30 Å/second or greater and the first deposition rate is 10 Å/second or less.

14. The method of claim 13, wherein the second deposition rate is in a range of 30 Å/second to 40 Å/second and the first deposition rate is in a range of5 Å/second to10 Å/second.

15. The method of claim 11, wherein the tungsten carbide initiation layer has a thickness in a range of 10 Å to 200 Å.