CLAIMS:

1. A deposition method comprising:

delivering a ruthenium-containing precursor and a hydrogen-containing precursor to a processing region of a semiconductor processing chamber, wherein at least one of the ruthenium-containing precursor or the hydrogen-containing precursor comprises carbon;

forming a plasma of all precursors within the processing region of a semiconductor processing chamber; and

depositing a ruthenium-and-carbon material on a substrate disposed within the processing region of the semiconductor processing chamber,

wherein the ruthenium-and-carbon material is characterized by an as-deposited surface roughness of less than 1.0 nm or about 1.0 nm.

2. The deposition method of claim 1, wherein the ruthenium-and-carbon material is characterized by an as-deposited surface roughness of less than 0.5 nm or about 0.5 nm.

3. The deposition method of claim 1, wherein the ruthenium-and-carbon material is characterized by a concentration of ruthenium greater than 5 at.% or about 5 at.%.

4. The deposition method of claim 1, wherein the ruthenium-and-carbon material is characterized by a grain size of less than 50 Å or about 50 Å.

5. The deposition method of claim 1, wherein a temperature of the substrate is maintained above 300 °C or at about 300 °C during the depositing the ruthenium-and-carbon material on the substrate.

6. The deposition method of claim 1, wherein a pressure is maintained below 15 Torr or at about 15 Torr during the depositing the ruthenium-and-carbon material on the substrate.

7. The deposition method of claim 1, wherein a low-frequency plasma power is maintained at greater than 100 W or at about 100 W while depositing the ruthenium-and-carbon material on the substrate.

8. The deposition method of claim 1, further comprising:

ramping one or more of a chamber pressure or a plasma power while depositing the ruthenium-and-carbon material on the substrate.

9. The deposition method of claim 1, further comprising:

providing an argon precursor with the ruthenium-containing precursor and the hydrogen-containing precursor.

10. The deposition method of claim 1, further comprising:

providing a boron-containing precursor or a nitrogen-containing precursor with the ruthenium-containing precursor and the hydrogen-containing precursor.

11. The deposition method of claim 1, further comprising:

removing the ruthenium-and-carbon material utilizing ozone.

12. The deposition method of claim 11, wherein removing the ruthenium-and-carbon material is performed at a substrate temperature below 300 °C or about 300 °C.

13. A deposition method comprising:

delivering a transition-metal-containing precursor and a hydrogen-containing precursor to a processing region of a semiconductor processing chamber, wherein at least one of the transition-metal-containing precursor or the hydrogen-containing precursor comprises carbon;

forming a plasma of all precursors within the processing region of a semiconductor processing chamber; and

depositing a transition-metal-and-carbon material on a substrate disposed within the processing region of the semiconductor processing chamber,

wherein the transition-metal-and-carbon material is characterized by a transition metal concentration of greater than 5 at.% or about 5 at.%, and an as-deposited surface roughness of less than 1.5 nm or about 1.5 nm.

14. The deposition method of claim 13, wherein the transition metal comprises ruthenium or osmium.

15. The deposition method of claim 13, further comprising:

ashing the transition-metal-and-carbon material from the substrate, wherein the ashing is performed with ozone or plasma-enhanced oxygen.

16. The deposition method of claim 15, wherein ashing the transition-metal-and-carbon material is performed at a substrate temperature below 300 °C or about 300 °C.

17. The deposition method of claim 13, further comprising:

ramping one or more of a chamber pressure or a plasma power while depositing the transition-metal-and-carbon material on the substrate.

18. The deposition method of claim 13, wherein a low-frequency plasma power is maintained at greater than 100 W or at about 100 W while depositing the transition-metal-and-carbon material on the substrate.

19. The deposition method of claim 13, wherein the transition-metal-containing precursor comprises an organometallic precursor, or a metal-halide precursor.

20. A deposition method comprising:

delivering a transition-metal-containing precursor and a hydrogen-containing precursor to a processing region of a semiconductor processing chamber, wherein at least one of the transition-metal-containing precursor or the hydrogen-containing precursor comprises carbon;

forming a plasma of all precursors within the processing region of a semiconductor processing chamber;

depositing a transition-metal-and-carbon material on a substrate disposed within the processing region of the semiconductor processing chamber, wherein the transition-metal-and-carbon material is characterized by a transition metal concentration of greater than 5 at.% or about 5 at.%; and

ashing the transition-metal-and-carbon material from the substrate, wherein the ashing is performed with ozone or plasma-enhanced oxygen.