CLAIMS

1. A method comprising:

(a) providing a substrate having a plurality of features spaced apart, each feature having a feature opening width, wherein the width of the feature narrows from the top of the feature to the bottom of the feature;

(b) depositing a bulk metal layer in the features; and

(c) after depositing the bulk metal layer in the features, depositing an amorphous metal-based layer in the features.

2. The method of claim 1, wherein the width of the bottom of each feature is between 0 nm and 90% of the width at the top of the each feature.

3. The method of claim 1 or 2, wherein the metal is selected from the group consisting of tungsten, ruthenium, molybdenum, and cobalt.

4. The method of any of claims 1-3, further comprising repeating (b) one or more times to fill the feature.

5. The method of claim 4, further comprising repeating (c) one or more times to fill the feature.

6. The method of any of claims 1–5, further comprising annealing the conformal amorphous metal-based layer.

7. The method of any of claims 1-6, wherein the features are spaced apart with a pitch of between about 10 nm and 60 nm between adjacent features.

8. The method of any of claims 1-7, further comprising depositing a metal nucleation layer in the features.

9. The method of any of claims 1-8, wherein the metal-based layer comprises at least 50% metal.

10. The method of claim 9, wherein the metal-based layer further comprises one or more of boron (B), nitrogen (N), carbon (C), silicon (Si), and germanium (Ge).

11. A method comprising:

(a) providing a substrate having a plurality of features spaced apart, each feature having a feature opening width, wherein the width of the feature narrows from the top of the feature to the bottom of the feature;

(b) conformally treating the surface by exposing it to a metal-containing precursor and an inhibition compound; and

(c) after treating the surface, depositing a bulk metal layer in the features.

12. The method of claim 11, wherein the width of the bottom of each feature is between 0 nm and 90% of the width at the top of the feature.

13. The method of claim 11 or 12, wherein the metal is selected from the group consisting of tungsten, ruthenium, molybdenum, and cobalt.

14. The method of any of claims 11–13, further comprising repeating (b) and (c) one or more times to fill the features.

15. The method of any of claims 11–14, wherein (b) is performed without depositing a continuous film in the feature.

16. The method of any of claims 11–15, wherein (b) comprises a non-uniform adsorption of the metal precursor and inhibition compound.

17. The method of any of claims 11–15, wherein (b) comprises deposition of a discontinuous film.

18. The method of any of claims 11–17, further comprising depositing a nucleation layer on in the features such that (b) comprises treating the nucleation layer surface.

19. The method of any of claims 11–18, wherein (b) increases the surface roughness of the bulk metal layer.

20. The method of any of claims 11–19, wherein (b) is a non-plasma thermal process.

21. The method of any of claims 11–19, wherein (b) is a plasma-based process.

22. The method of any of claims 11–21, wherein the inhibition chemistry includes a nitrogen-containing compound.

23. The method of any of claims 11–21 wherein the inhibition chemistry is ammonia.

24. A method comprising:

(a) providing a substrate having a plurality of features spaced apart, each feature having a feature opening width, wherein the width of at least some of the features narrows from the top of the feature to the bottom of the feature;

(b) depositing a conformal amorphous metal-based layer in the features; and

(c) after depositing the conformal amorphous metal-based layer, depositing a bulk metal layer in the features.

25. The method of claim 24, wherein the width of the bottom of each feature is between 0 nm and 90% of the width at the top of the feature.

26. The method of claim 24 or 25, wherein the metal is selected from the group consisting of tungsten, ruthenium, molybdenum, and cobalt.

27. The method of any of claims 24–26, further comprising repeating (b) and (c) one or more times to fill the features.

28. The method of any of claims 24–27, further comprising annealing the conformal amorphous metal-based layer.

29. The method of any of claims 24–28, wherein the features are spaced apart with a pitch of between about 10 nm and 60 nm between adjacent features.

30. The method of any of claims 24–29, further comprising depositing a metal nucleation layer in the features.

31. The method of any of claims 24–30, wherein the metal-based layer comprises at least 50 atomic % metal.

32. The method of claim 24–31, wherein the metal-based layer further comprises one or more of boron (B), nitrogen (N), carbon (C), silicon (Si), and germanium (Ge).

33. A method comprising:

providing a substrate having a plurality of features spaced apart, each feature having a feature opening width, wherein the width of at least some of the features narrows from the top of the feature to the bottom of the feature; and

depositing a conformal metal-based layer in the features, wherein the metal-based layer comprises a metal selected from tungsten (W), ruthenium (Ru), molybdenum (Mo), titanium (Ti), tantalum (Ta), and cobalt (Co) and wherein the metal-based layer is at least 5% (atomic) of an impurity selected from boron (B), nitrogen (N), carbon (C), silicon (Si), germanium (Ge), and

combinations thereof.

34. The method of claim 33, wherein the plurality of features are filled with a film selected from titanium nitride and tantalum nitride.

35. A method comprising:

(a) providing a substrate having a plurality of features spaced apart, each feature having a feature opening width, wherein the width of the feature narrows from the top of the feature to the bottom of the feature;

(b) performing a treatment to depositing a conformal, discontinuous film in the features or adsorb metal species non-uniformly throughout each feature; and

(c) after (b), depositing a bulk layer in the features.