CLAIMS

1. A semiconductor processing method comprising:

etching one or more features partially through a stack of layers formed on a substrate;

halting the etching prior to penetrating fully through the stack of layers formed on the substrate;

forming a layer of carbon-containing material along the stack of layers on the substrate, wherein forming the layer of carbon-containing material comprises two or more alternating cycles of:

providing a first molecular species to form a first non-metallic molecular layer; and

providing a second molecular species to form a second non-metallic molecular layer on the first molecular layer;

forming a metal-containing liner on the carbon-containing material by performing two or more alternating cycles of:

providing a metal-containing precursor to form a metal-containing layer over the layer of carbon-containing material; and

providing an oxygen-containing precursor after the metal-containing layer is formed; and

etching the one or more features fully through the stack of layers on the substrate.

2. The semiconductor processing method of claim 1, wherein:

the first molecular species couples with the stack of layers formed on the substrate; and

the second molecular species couples with the first molecular species.

3. The semiconductor processing method of claim 2, wherein the first molecular species is characterized by a head group comprising an amine, diamine, diol, or dithiol.

4. The semiconductor processing method of claim 3, wherein the second molecular species comprises oxygen.

5. The semiconductor processing method of claim 2, wherein the metal-containing precursor couples with the second non-metallic molecular layer.

6. The semiconductor processing method of claim 5, wherein the oxygen-containing precursor comprises water vapor, oxygen, ozone, or ethylene glycol.

7. The semiconductor processing method of claim 1, wherein the layer of carbon-containing material is formed to a thickness of greater than or equal to 10 nm.

8. The semiconductor processing method of claim 1, wherein forming the layer of carbon-containing material is performed at a substrate temperature of less than or equal to 200 °C.

9. The semiconductor processing method of claim 1, wherein the stack of layers comprises alternating oxide layers and either nitride or polysilicon layers, and wherein the etch rates through the oxide layers and the nitride or polysilicon layers are higher than the etch rate through the carbon-containing material.

10. The semiconductor processing method of claim 1, wherein the metal-containing layer comprises one or more of aluminum, titanium, zinc, hafnium, tantalum, or zirconium.

11. A semiconductor processing method comprising:

etching one or more features partially through a stack of layers formed on a substrate,

wherein the stack of layers comprises alternating layers including silicon oxide; and

wherein the stack of layers comprises more than 100 layers;

halting the etching prior to penetrating fully through the stack of layers formed on the substrate;

forming a protective liner along the stack of layers on the substrate, wherein forming the protective liner comprises:

forming a layer of non-metallic carbon-containing material along the stack of layers on the substrate, wherein forming the layer of non-metallic carbon-containing material comprises two or more alternating cycles of:

providing a first molecular species to form a first non-metallic molecular layer; and

providing a second molecular species to form a second non-metallic molecular layer on the first molecular layer;

forming a metal-containing liner on the non-metallic carbon-containing material by performing two or more alternating cycles of:

providing a metal-containing precursor to form a metal-containing layer over the layer of non-metallic carbon-containing material; and

providing an oxygen-containing precursor after the metal-containing layer is formed; and

etching the one or more features fully through the stack of layers on the substrate.

12. The semiconductor processing method of claim 11, further comprising:

removing the layer of non-metallic carbon-containing material from the stack of layers formed on the substrate.

13. The semiconductor processing method of claim 11, wherein the first non-metallic molecular layer and the second non-metallic molecular layer are formed by molecular layer deposition (MLD).

14. The semiconductor processing method of claim 11, wherein the first molecular species comprises a head group that comprises a bifunctional or polyfunctional material.

15. The semiconductor processing method of claim 11, wherein:

the non-metallic carbon-containing material is formed at a substrate temperature of less than 200 °C;

etching the one or more features fully through the stack of layers on the substrate leaves a portion of the non-metallic carbon-containing material on the substrate; and

the method further comprises removing the remaining portion of the layer of non-metallic carbon-containing material from the stack of layers formed on the substrate by annealing at a temperature of greater than 200 °C.

16. The semiconductor processing method of claim 11, wherein forming the layer of non-metallic carbon-containing material comprises 25 or more alternating cycles of providing the first molecular species and providing the second molecular species.

17. A semiconductor processing method comprising:

etching one or more features partially through a stack of layers formed on a substrate, wherein the stack of layers comprises alternating layers including silicon oxide, and wherein the stack of layers comprises more than 100 layers;

halting the etching prior to penetrating fully through the stack of layers formed on the substrate;

conformally forming a layer of carbon-containing material along the stack of layers on the substrate, wherein forming the layer of carbon-containing material comprises two or more alternating cycles of:

providing a first molecular species to form a first non-metallic molecular layer; and

providing a second molecular species to form a second non-metallic molecular layer on the first molecular layer;

conformally forming a metal-containing liner on the carbon-containing material by performing two or more alternating cycles of:

providing a metal-containing precursor to form a metal-containing layer over the layer of carbon-containing material; and

providing an oxygen-containing precursor after the metal-containing layer is formed; and

etching the one or more features fully through the stack of layers on the substrate.

18. The semiconductor processing method of claim 17, wherein the carbon-containing material is formed conformally to cover the one or more features and a top surface of the stack outside of the one or more features.

19. The semiconductor processing method of claim 17, wherein etching the one or more features partially through the stack of layers comprises etching the one or more features to a depth equal to 50% of a thickness of the stack of layers.