

CLAIMS:

1. A processing method comprising:
 - flowing a first deposition precursor into a substrate processing region to form a first portion of an initial compound layer, wherein the first deposition precursor comprises an aldehyde reactive group;
 - removing a first deposition effluent comprising the first deposition precursor from the substrate processing region;
 - flowing a second deposition precursor into the substrate processing region, wherein the second deposition precursor comprises an amine reactive group, and wherein the amine reactive group reacts with the aldehyde reactive group, to form a second portion of the initial compound layer;
 - removing a second deposition effluent comprising the second deposition precursor from the substrate processing region; and
 - annealing the initial compound layer at a temperature between 300°C and 600°C to form an annealed carbon-containing material on a surface of a substrate.
2. The processing method of claim 1, where the processing method further comprises:
 - depositing at least one additional compound layer on the initial compound layer, wherein the initial compound layer and the at least one additional compound layer form the annealed carbon-containing material on the surface of the substrate.
3. The processing method of claim 1, wherein the first deposition precursor is delivered at a temperature greater than or equal to 100°C.
4. The processing method of claim 1, wherein the second deposition precursor is delivered at a temperature less than 100°C.
5. The processing method of claim 1, wherein the first deposition time and the second deposition time are less than 5 seconds.
6. The processing method of claim 1, wherein the first deposition time is longer than the second deposition time.

7. The processing method of claim 1, wherein the flowing of the first deposition precursor increases pressure in the substrate processing region to a pressure range of 1 mTorr to 500 Torr.

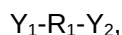
8. The processing method of claim 1, wherein the removal of the first deposition effluent from the substrate processing region has a removal time of less than 60 seconds.

9. The processing method of claim 1, wherein the annealing of the initial compound layer comprises a thermal annealing at a temperature ranging from 300°C to 450°C.

10. The processing method of claim 1, wherein the initial compound layer shrinks by less than 10 vol% due to the annealing of the initial compound layer.

11. The processing method of claim 1, wherein the substrate comprises a substrate feature characterized by an aspect ratio of greater than or equal to 5:1, and wherein the substrate feature is characterized by a width across the substrate feature of less than 10 nm.

12. A processing method comprising:
flowing a first deposition precursor into a substrate processing region, wherein the first deposition precursor has a first formula comprising:



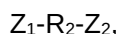
wherein R_1 comprises one or more of an alkyl group, an aromatic group, or a cycloalkyl group,

wherein Y_1 and Y_2 independently comprise a hydroxide group, an aldehyde group, a ketone group, an acid group, an amino group, an isocyanate group, a thiocyanate group, or an acyl chloride group, and

wherein the first deposition precursor reacts with a reactive group on a surface of a substrate in the substrate processing region to form a first portion of an initial compound layer on the surface of the substrate;

removing a first deposition effluent comprising the first deposition precursor from the substrate processing region;

flowing a second deposition precursor into the substrate processing region, wherein the second deposition precursor has a second formula comprising:



wherein R_2 comprises one or more of an alkyl group, an aromatic group, or a cycloalkyl group,

wherein Z_1 and Z_2 independently comprise a hydroxide group, an aldehyde group, a ketone group, an acid group, an amino group, an isocyanate group, a thiocyanate group, or an acyl chloride group, and

wherein the second deposition precursor reacts with the first portion of the initial compound layer to form a second portion of the initial compound layer;

removing a second deposition effluent comprising the second deposition precursor from the substrate processing region; and

annealing the initial compound layer at a temperature between 300°C and 600°C to form an annealed carbon-containing material on the surface of the substrate.

13. The processing method of claim 12, wherein R_1 comprises an aromatic group, Y_1 and Y_2 independently comprise an aldehyde group or an isocyanate group, R_2 comprises an alkyl group, and Z_1 and Z_2 comprise an amino group.

14. The processing method of claim 12, wherein the first deposition precursor comprises terephthalaldehyde or 1,4-phenylene diisocyanate.

15. The processing method of claim 12, wherein the second deposition precursor comprises ethylene diamine.

16. The processing method of claim 12, wherein the removing of the first deposition precursor comprises:

flowing a purge gas into the substrate processing region; and

removing a mixture of the first deposition effluent and the purge gas from the substrate processing region.

17. The processing method of claim 16, wherein the purge gas comprises helium.

18. A processing method comprising performing two or more cycles of forming a carbon-containing composite layer on a substrate to form two or more carbon-containing composite layers, wherein each of the two or more cycles of forming the carbon-containing composite layer comprises:

forming a first portion of an initial compound layer on a surface of the substrate, wherein the first portion of the initial compound layer is formed by flowing a first deposition precursor into a substrate processing region,

wherein the first deposition precursor reacts with a reactive group on the surface of the substrate in the substrate processing region to form the first portion of the initial compound layer, and

wherein the first deposition precursor is delivered into the substrate processing region at a first temperature,

forming a second portion of the initial compound layer on at least a portion of the first portion of the initial compound layer, wherein the second portion of the initial compound layer is formed by flowing a second deposition precursor into the substrate processing region,

wherein the second deposition precursor reacts with the first portion of the initial compound layer to form the second portion of the initial compound layer, and

wherein the second deposition precursor is delivered into the substrate processing region at a second temperature less than the first temperature; and annealing the two or more carbon-containing composite layers on the substrate to form an annealed carbon-containing material on the surface of the substrate.

19. The processing method of claim 18, wherein the first deposition precursor comprises terephthalaldehyde or 1,4-phenylene diisocyanate, and the second deposition precursor comprises ethylene diamine.

20. The processing method of claim 18, wherein the two or more carbon-containing composite layers shrink by less than 10 vol% due to the annealing of the two or more carbon-containing composite layers.