Claims

1. A method, comprising:

disposing a silicon-and-oxygen-containing layer in one or more trenches on a substrate, the silicon-and-oxygen-containing layer having terminal silanol groups and the trench having:

a width of 10 nanometers (nm) or less; and

an aspect ratio of 2:1 or greater, the aspect ratio defined by a ratio of a depth to the width of the one or more trenches;

transferring the substrate having the silicon-and-oxygen-containing layer thereon into a chamber;

heating the substrate in the chamber; and

exposing the silicon-and-oxygen-containing layer to an ammonia or amine group-containing catalyst distributed across a process volume of the chamber.

2. The method of claim 1, wherein positioning the substrate comprises:

transferring the substrate to a substrate support of the chamber; and

elevating the substrate support an elevated processing position to a process distance of about 0.25 inches to about 5 inches between the substrate support and a showerhead of the chamber.

3. The method of claim 1, wherein a pressure in the chamber is about 0.5 Torr to about 600 Torr.

4. The method of claim 1, wherein the ammonia or amine group-containing catalyst is introduced to the process volume at a flow rate of about 0.1 SLM to about 25 SLM.

5. The method of claim 1, wherein inert gas is introduced to the process volume at a flow rate of about 1 SLM to about 10 SLM.

6. The method of claim 1, wherein the ammonia or amine group-containing catalyst comprises ammonia.

7. The method of claim 1, further comprising transferring the substrate to an ultraviolet (UV) curing chamber and UV curing the silicon-and-oxygen-containing layer after exposing the silicon-and-oxygen-containing layer to the ammonia or amine group-containing catalyst.

8. A method, comprising:

positioning a substrate on a substrate support in a chamber, the substrate having:

one or more trenches comprising:

a width of 10 nanometers (nm) or less; and

an aspect ratio of 2:1 or greater, the aspect ratio defined by a ratio of a depth to the width of the one or more trenches;

depositing a silicon-and-oxygen-containing layer in the one or more trenches, the silicon-and-oxygen-containing layer having terminal silanol groups;

heating the substrate support with the substrate thereon to a temperature of about 10°C to about 1000 °C; and

exposing the silicon-and-oxygen-containing layer to an ammonia or amine group-containing catalyst distributed across a process volume, the exposing comprising cross-linking adjacent terminal silanol groups to form a polymerized silicon-and-oxygen-containing layer.

9. The method of claim 8, wherein the depositing the silicon-and-oxygen-containing layer comprises:

introducing oxygen radicals and a silicon-containing precursor to the process volume of the chamber, the oxygen radicals polymerizing the silicon-containing precursor to deposit the silicon-and-oxygen-containing layer in the one or more trenches with the terminal silanol groups.

10. The method of claim 9, further comprising:

prior to the introducing the oxygen radicals and the silicon-containing precursor, elevating the substrate support a first process distance of about 0.5 inches to about 5 inches between the substrate support and a showerhead of the chamber; and

prior to the exposing the silicon-and-oxygen-containing layer to the ammonia or amine group-containing catalyst, elevating the substrate support a second process distance of about 0.25 inches to about 5 inches between the substrate support and the showerhead.

11. The method of claim 10, wherein the silicon-containing precursor comprises one or more of siloxanes, carbo-silanes, octamethylcyclotetrasiloxane (OMCTS), tetramethylcyclotetrasiloxane (TMCTS), octadecyltrichlorosilane (OTS), hexamethyldisiloxane (HMDSO), tetramethyldisiloxane (TMDSO), tetraethoxysilane (TEOS), bis(trimethylsilyl)methane (BTMSM), methylenebis(dimethylsilane), methylenebis(methylsilane), methylenedisilane, silane, disilane, trisilylamine, or any combination thereof.

12. The method of claim 8, wherein a pressure in the chamber during the exposing the silicon-and-oxygen-containing layer to the ammonia or amine group-containing catalyst is about 0.5 Torr to about 50 Torr.

13. The method of claim 8, wherein the ammonia or amine group-containing catalyst is introduced to the process volume at a flow rate of about 0.1 SLM to about 25 SLM.

14. The method of claim 8, wherein inert gas is provided to the process volume at a flow rate of about 1 SLM to about 10 SLM.

15. The method of claim 8, wherein the ammonia or amine group-containing catalyst comprises one or more of ammonia, methylamine, dimethylamine, trimethylamine, ethylamine, diethylamine, triethylamine, or any combination thereof.

16. The method of claim 8, wherein the one or more trenches comprise a silicon nitride layer and a titanium layer disposed therein, and wherein the silicon-and-oxygen-containing layer is formed over the silicon nitride layer and the titanium layer.

17. The method of claim 8, further comprising transferring the substrate to an ultraviolet (UV) curing chamber and UV curing the silicon-and-oxygen-containing layer after exposing the silicon-and-oxygen-containing layer to the ammonia or amine group-containing catalyst.

18. A method, comprising:

positioning a substrate on a substrate support in a first chamber, the substrate having:

one or more trenches comprising:

a width of 10 nanometers (nm) or less; and

an aspect ratio of 2:1 or more, the aspect ratio defined by a ratio of a height to the width of the one or more trenches;

depositing a silicon-and-oxygen-containing layer, the depositing the silicon-and-oxygen-containing layer comprising:

introducing oxygen radicals and a silicon-containing precursor to a process volume of the first chamber, wherein the oxygen radicals and the silicon-containing precursor deposit the silicon-and-oxygen-containing layer over the one or more trenches with terminal silanol groups;

removing the substrate from the first chamber and positioning the substrate in a second chamber;

heating the substrate support with the substrate thereon to a temperature of about 10°C to about 1000°C;

exposing the silicon-and-oxygen-containing layer to an ammonia or amine group-containing catalyst distributed across a process volume, the exposing comprising cross-linking adjacent terminal silanol groups to form a polymerized silicon-and-oxygen-containing layer, the forming the polymerized silicon-and-oxygen-containing layer generating H_2O; and

exhausting the H_2O from the chamber.

19. The method of claim 18, wherein the ammonia or amine group-containing catalyst comprises one or more of ammonia, methylamine, dimethylamine, trimethylamine, ethylamine, diethylamine, triethylamine, or any combination thereof.

20. The method of claim 18, further comprising transferring the substrate to an ultraviolet (UV) curing chamber and UV curing the silicon-and-oxygen-containing layer after exposing the silicon-and-oxygen-containing layer to the ammonia or amine group-containing catalyst.

21. The method of claim 1, wherein the exposing comprises cross-linking adjacent terminal silanol groups to form a polymerized silicon-and-oxygen-containing layer.