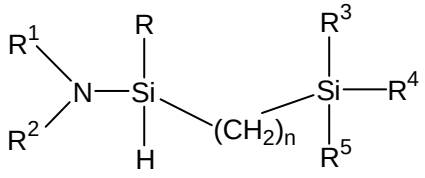
CLAIMS

1. A method for depositing a film comprising silicon and oxygen onto a substrate, the method comprising the steps of:

   a) providing a substrate in a reactor;

   b) introducing into the reactor at least one silicon precursor compound comprising at least one organoaminocarbosilane compound, wherein the at least one organoaminocarbosilane compound has at least one SiH_2 or SiMeH group and is represented by the structure of Formula A:



A

wherein

R^1 is selected from the group consisting of a linear or branched C_1 to C_{10} alkyl group, a linear or branched C_3 to C_{10} alkenyl group, a linear or branched C_3 to C_{10} alkynyl group, a C_1 to C_6 dialkylamino group, a C_6 to C_{10} aryl group, a C_3 to C_{10} cyclic alkyl group, a branched C_4 to C_{10} cyclic alkyl group, a C_3 to C_{10} cyclic alkenyl group, a branched C_4 to C_{10} cyclic alkenyl group, a C_3 to C_6 cyclic alkynyl group, a branched C_3 to C_6 cyclic alkynyl group, a C_1 to C_6 dialkylamino group, and a C_1 to C_6 alkylamino group;

R^2 is selected from the group consisting of hydrogen, a linear or branched C_1 to C_{10} alkyl group, a linear or branched C_3 to C_{10} alkenyl group, a linear or branched C_3 to C_{10} alkynyl group, a C_1 to C_6 dialkylamino group, a C_6 to C_{10} aryl group, a C_3 to C_{10} cyclic alkyl group, a branched C_4 to C_{10} cyclic alkyl group, a C_3 to C_{10} cyclic alkenyl group, a branched C_4 to C_{10} cyclic alkenyl group, a C_3 to C_6 cyclic alkynyl group, a branched C_3 to C_6 cyclic alkynyl group, and a C_4 to C_{10} aryl group;

R^{3-5} are each independently selected from the group consisting of hydrogen, a linear or branched C_1 to C_{10} alkyl group, a linear or branched C_3 to C_{10} alkenyl group, a linear or branched C_3 to C_{10} alkynyl group, a C_6 to C_{10} aryl group, a C_3 to C_{10} cyclic alkyl group, a branched C_4 to C_{10} cyclic alkyl group, a C_3 to C_{10} cyclic alkenyl group, a branched C_4 to C_{10} cyclic alkenyl group, a C_3 to C_6 cyclic alkynyl group, a branched C_3 to C_6 cyclic alkynyl group, and a C_4 to C_{10} aryl group; and

R is selected from the group consisting of hydrogen and methyl

provided that R and R^{3-5} cannot be all hydrogen; and n = 2 or 3;

c) purging the reactor with a purge gas;

d) introducing an oxygen-containing source into the reactor; and

e) purging the reactor with a purge gas,

wherein steps b through e are repeated until a desired thickness of the film is deposited, and

wherein the method is conducted at one or more temperatures ranging from 25°C to 600°C.

2. The method of claim 1, wherein the compound of Formula A is selected from the group consisting of 1-dimethylamino-4,4-dimethyl-1,4-disilapentane, 1-diethylamino-4,4-dimethyl-1,4-disilapentane, 1-ethylmethylamino-4,4-dimethyl-1,4-disilapentane, 1-di-iso-propylamino-4,4-dimethyl-1,4-disilapentane, 1-di-sec-butylamino-4,4-dimethyl-1,4-disilapentane, 1-piperindino-sec-butylamino-4,4-dimethyl-1,4-disilapentane, 1-piperindino-sec-butylamino-4,4-dimethyl-1,4-disilapentane, 1-pyrrolidino-4,4-dimethyl-1,4-disilapentane, 1-2,5-dimethylpyrrolidino-4,4-dimethyl-1,4-disilapentane, 1-cyclohexylmethylamino-4,4-dimethyl-1,4-disilapentane, 1-cyclohexylethylamino-4,4-dimethyl-1,4-disilapentane, 1-cyclohexyl-iso-propylamino-4,4-dimethyl-1,4-disilapentane, 1-dimethylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-dimethylamino-1-methyl-4,4-diethyl-1,4-disilapentane, 1-ethylmethylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-di-iso-propylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-di-sec-butylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-piperindino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-2,5-dimethylpiperindino-sec-butylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-pyrrolidino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-2,5-dimethylpyrrolidino-1-

methyl-4,4-dimethyl-1,4-disilapentane, 1-cyclohexylmethylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-cyclohexylethylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-cyclohexyl-iso-propylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-dimethylamino-5,5-dimethyl-1,5-disilahexane, 1-diethylamino-5,5-dimethyl-1,5-disilahexane, 1-ethylmethylamino-4,4-dimethyl-4,4-dimethyl-1,5-disilahexane, 1-di-iso-propylamino-5,5-dimethyl-1,5-disilahexane, 1-di-sec-butylamino-5,5-dimethyl-1,5-disilahexane, 1-piperindino-5,5-dimethyl-1,5-disilahexane, 1-2,6-dimethylpiperindino-5,5-dimethyl-1,5-disilahexane, 1- pyrrolidino -5,5-dimethyl-1,5-disilahexane, 1-2,5-dimethylpyrrolidino -5,5-dimethyl-1,5-disilahexane, 1-cyclohexylmethylamino-5,5-dimethyl-1,5-disilahexane, 1-cyclohexylethylamino-5,5-dimethyl-1,5-disilahexane, 1-cyclohexyl-iso-propylamino-5,5-dimethyl-1,5-disilahexane, 1-dimethylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-diethylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-ethylmethylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-di-iso-propylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-di-sec-butylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-piperindino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-2,6-dimethylpiperindino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1- pyrrolidino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-2,5-dimethylpyrrolidino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-cyclohexylmethylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-cyclohexylethylamino-1-methyl5,5-dimethyl-1,5-disilahexane, and 1-cyclohexyl-iso-propylamino-1-methyl-5,5-dimethyl-1,5-disilahexane.

3. The method of claim 1, wherein the oxygen-containing source is selected from the group consisting of ozone, an oxygen plasma, a plasma comprising oxygen and argon, a plasma comprising oxygen and helium, an ozone plasma, a water plasma, a nitrous oxide plasma, a carbon dioxide plasma, and combinations thereof.

4. The method of claim 1 wherein the oxygen-containing source comprises a plasma.

5. The method of claim 4 wherein the plasma is generated in situ.

6. The method of claim 4 wherein the plasma is generated remotely.

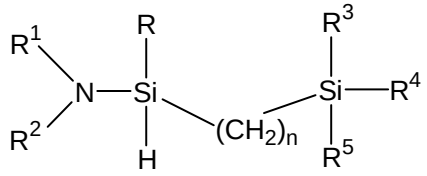
7. The method of claim 4 wherein the film has a density of 2.0 g/cm^3 or greater.

8. The method of claim 1 wherein the film further comprises carbon.

9. The method of claim 8 wherein the film has a density of 1.8 g/cm^3 or greater.

10. The method of claim 8 wherein the carbon content of the film is 0.5 atomic weight percent (at.%) or greater as measured by x-ray photospectroscopy.

11. A composition for depositing a silicon oxide film or a carbon doped silicon oxide film using a vapor deposition process, wherein the composition comprises: at least one silicon precursor having a structure represented by Formula A:



A

wherein

R^1 is selected from the group consisting of a linear or branched C_1 to C_{10} alkyl group, a linear or branched C_3 to C_{10} alkenyl group, a linear or branched C_3 to C_{10} alkynyl group, a C_1 to C_6 dialkylamino group, a C_6 to C_{10} aryl group, a C_3 to C_{10} cyclic alkyl group, a branched C_4 to C_{10} cyclic alkyl group, a C_3 to C_{10} cyclic alkenyl group, a branched C_4 to C_{10} cyclic alkenyl group, a C_3 to C_6 cyclic alkynyl group, a branched C_3 to C_6 cyclic alkynyl group, a C_1 to C_6 dialkylamino group, and a C_1 to C_6 alkylamino group;

R^2 is selected from the group consisting of hydrogen, a linear or branched C_1 to C_{10} alkyl group, a linear or branched C_3 to C_{10} alkenyl group, a linear or branched C_3 to C_{10} alkynyl group, a C_1 to C_6 dialkylamino group, a C_6 to C_{10} aryl group, a C_3 to C_{10} cyclic alkyl group, a branched C_4 to C_{10} cyclic alkyl group, a C_3 to C_{10} cyclic

alkenyl group, a branched C_4 to C_{10} cyclic alkenyl group, a C_3 to C_6 cyclic alkynyl group, a branched C_3 to C_6 cyclic alkynyl group, and a C_4 to C_{10} aryl group;

R^{3-5} are each independently selected from the group consisting of hydrogen, a linear or branched C_1 to C_{10} alkyl group, a linear or branched C_3 to C_{10} alkenyl group, a linear or branched C_3 to C_{10} alkynyl group, a C_6 to C_{10} aryl group, a C_3 to C_{10} cyclic alkyl group, a branched C_4 to C_{10} cyclic alkyl group, a C_3 to C_{10} cyclic alkenyl group, a branched C_4 to C_{10} cyclic alkenyl group, a C_3 to C_6 cyclic alkynyl group, a branched C_3 to C_6 cyclic alkynyl group, and a C_4 to C_{10} aryl group; and

R is selected from the group consisting of hydrogen and methyl; and provided that R and R^{3-5} cannot be all hydrogen; and

n = 2 or 3.

12. The composition of claim 11, wherein the at least one compound is selected from the group consisting of 1-dimethylamino-4,4-dimethyl-1,4-disilapentane, 1-diethylamino-4,4-dimethyl-1,4-disilapentane, 1-ethylmethylamino-4,4-dimethyl-1,4-disilapentane, 1-di-iso-propylamino-4,4-dimethyl-1,4-disilapentane, 1-di-sec-butylamino-4,4-dimethyl-1,4-disilapentane, 1-piperindino-sec-butylamino-4,4-dimethyl-1,4-disilapentane, 1-piperindino-sec-butylamino-4,4-dimethyl-1,4-disilapentane, 1-pyrrolidino-4,4-dimethyl-1,4-disilapentane, 1-2,5-dimethylpyrrolidino-4,4-dimethyl-1,4-disilapentane, 1-cyclohexylmethylamino-4,4-dimethyl-1,4-disilapentane, 1-cyclohexylethylamino-4,4-dimethyl-1,4-disilapentane, 1-cyclohexyl-iso-propylamino-4,4-dimethyl-1,4-disilapentane, 1-dimethylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-dimethylamino-1-methyl-4,4-diethyl-1,4-disilapentane, 1-ethylmethylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-di-iso-propylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-di-sec-butylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-piperindino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-2,5-dimethylpiperindino-sec-butylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-pyrrolidino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-2,5-dimethylpyrrolidino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-cyclohexylmethylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-cyclohexylethylamino-1-methyl-4,4-dimethyl-1,4-disilapentane, 1-cyclohexyl-iso-propylamino-1-methyl-4,4-dimethyl-1,4-disilapentane,

1-dimethylamino-5,5-dimethyl-1,5-disilahexane, 1-diethylamino-5,5-dimethyl-1,5-disilahexane, 1-ethylmethylamino-4,4-dimethyl-4,4-dimethyl-1,5-disilahexane, 1-di-iso-propylamino-5,5-dimethyl-1,5-disilahexane, 1-di-sec-butylamino-5,5-dimethyl-1,5-disilahexane, 1-piperindino-5,5-dimethyl-1,5-disilahexane, 1-2,6-dimethylpiperindino-5,5-dimethyl-1,5-disilahexane, 1- pyrrolidino -5,5-dimethyl-1,5-disilahexane, 1-2,5-dimethylpyrrolidino -5,5-dimethyl-1,5-disilahexane, 1-cyclohexylmethylamino-5,5-dimethyl-1,5-disilahexane, 1-cyclohexylethylamino-5,5-dimethyl-1,5-disilahexane, 1-cyclohexyl-iso-propylamino-5,5-dimethyl-1,5-disilahexane, 1-dimethylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-diethylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-ethylmethylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-di-iso-propylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-di-sec-butylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-piperindino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-2,6-dimethylpiperindino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1- pyrrolidino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-2,5-dimethylpyrrolidino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-cyclohexylmethylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, 1-cyclohexylethylamino-1-methyl5,5-dimethyl-1,5-disilahexane, 1-cyclohexyl-iso-propylamino-1-methyl-5,5-dimethyl-1,5-disilahexane, and combinations thereof.

13. A film obtained by the method of claim 1.

14. The film of claim 13 comprising at least one of the following characteristics: a density of at least about 2.0 g/cm^3; a wet etch rate that is less than about 2.5 Å/s as measured in a solution of 1:100 of HF to water (0.5 wt. % dHF) acid; an electrical leakage of less than about 1 e-8 A/cm^2 up to 6 MV/cm; and a hydrogen impurity of less than about 4 e 21 at/cc as measured by SIMS.

15. The method of claim 1 wherein the organoaminocarbosilane compound is substantially free of one or more impurities selected from the group consisting of halide compounds, metal ions, metals, and combinations thereof.

16. The composition of claim 11 wherein the composition is substantially free of one or more impurities selected from the group consisting of halide compounds, metal ions, metals, and combinations thereof.

17. The composition of claim 16, wherein the halide compounds comprise chloride-containing species.

18. The composition of claim 16, wherein the chloride concentration is less than 50 ppm measured by IC.

19. The composition of claim 16, wherein the chloride concentration is less than 10 ppm measured by IC.

20. The composition of claim 16, wherein the chloride concentration is less than 5 ppm measured by IC.

21. The composition of claim 11 wherein the composition is free of one or more impurities selected from the group consisting of halide compounds, metal ions, metals, and combinations thereof.

22. The composition of claim 21 wherein the composition is free of chlorides.