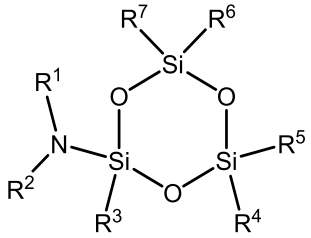
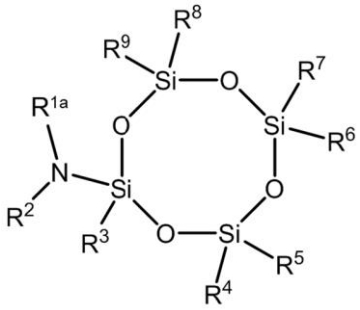
CLAIMS

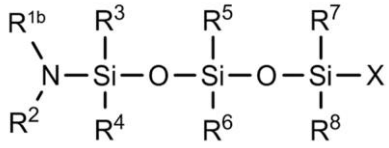
1. A composition comprising at least one organoamino-functionalized oligosiloxane compound selected from the group consisting of Formulae A, B, C, D and E:



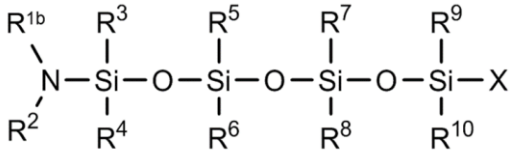
A ,



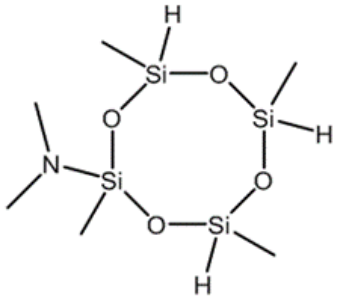
B ,



C ,



D and



E ,

wherein

R^1 is selected from a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, and a C_3 to C_{10} alkynyl group;

R^{1a} is selected from a linear C_2 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group;

R^{1b} is selected from a linear C_1, C_2, C_4 to C_{10} alkyl group, a branched C_4 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_5 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group;

R^2 is selected from the group consisting of hydrogen, a C_1 to C_{10} linear alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group, wherein R^1 and R^2 are either linked to form a cyclic ring structure or are not linked to form a cyclic ring structure, wherein R^{1a} and R^2 are either linked to form a cyclic ring structure or are not linked to form a cyclic ring structure, and wherein R^{1b} and R^2 are not linked to form a cyclic ring structure;

$R^{3\text{-}10}$ are each independently selected from hydrogen, a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group; and

X is selected from the group consisting of a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, a C_4 to C_{10} aryl group, a C_1 to C_{10} acyl group, an amine group (-NR^1R^2 or -$NR^{1a}R^2$ or -$NR^{1b}R^2$), H, Cl, Br, I, F, a C_2 to C_{12} carboxylate group, a C_1 to C_{10} linear or branched alkoxy group, a trimethylsiloxy group, a dimethylsiloxy group, a methylsiloxy group, and a siloxy group,

wherein R^{1b} and X are either linked to form a cyclic ring or are not linked to form a cyclic ring, wherein if R^{1b} and $R^{2\text{-}8}$ are all methyl groups in Formula C, X cannot be a trimethylsiloxy group, and wherein if R^{1b} and $R^{2\text{-}10}$ are all methyl groups in Formula D, X cannot be a methyl or dimethylamino group.

2. The composition of claim 1 comprising at least one compound selected from the group consisting of Formula A, Formula B and Formula E.

3. The composition of claim 1 comprising at least one compound selected from the group consisting of Formula C and Formula D.

4. The composition of claim 1 further comprising at least one selected from the group consisting of a solvent and a purge gas.

5. The composition of claim 2 wherein each of R^{2-9} is independently selected from hydrogen and a C_1 to C_4 alkyl group.

6. The composition of claim 1, wherein the composition is substantially free of one or more impurities selected from the group consisting of a halide, metal ions, metal, and combinations thereof.

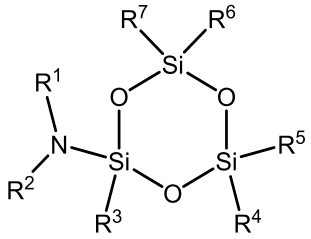
7. The composition of claim 2, wherein the organoamino-functionalized oligosiloxane compound is selected from the group consisting of:

2-dimethylamino-2,4,4,6,6-pentamethylcyclotrisiloxane, 2-diethylamino-2,4,4,6,6-pentamethylcyclotrisiloxane, 2-ethylmethylamino-2,4,4,6,6-pentamethylcyclotrisiloxane, 2-iso-propylamino-2,4,4,6,6-pentamethylcyclotrisiloxane, 2-diethylamino-2,4,4,6,6,8,8-heptamethylcyclotetrasiloxane, 2-ethylmethylamino-2,4,4,6,6,8,8-heptamethylcyclotetrasiloxane, 2-iso-propylamino-2,4,4,6,6,8,8-heptamethylcyclotetrasiloxane, 2-dimethylamino-2,4,6-trimethylcyclotrisiloxane, 2-diethylamino-2,4,6-trimethylcyclotrisiloxane, 2-ethylmethylamino-2,4,6-trimethylcyclotrisiloxane, 2-iso-propylamino-2,4,6-trimethylcyclotrisiloxane, 2-dimethylamino-2,4,6,8-tetramethylcyclotetrasiloxane, 2-diethylamino-2,4,6,8-tetramethylcyclotetrasiloxane, 2-ethylmethylamino-2,4,6,8-tetramethylcyclotetrasiloxane, and 2-iso-propylamino-2,4,6,8-tetramethylcyclotetrasiloxane.

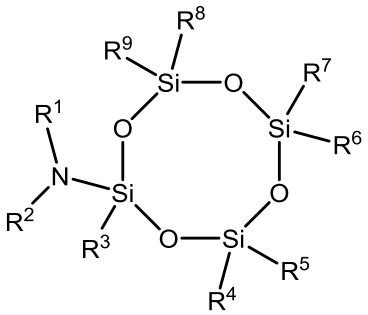
8. The composition of claim 3, wherein the organoamino-functionalized oligosiloxane compound is selected from the group consisting of:

1-dimethylamino-1,1,3,3,5,5-hexamethyl-5-methoxytrisiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7-octamethyl-7-methoxytrisiloxane, 1-dimethylamino-1,1,3,3,5,5-hexamethyl-5-acetoxytrisiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7-octamethyl-7-acetoxytrisiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7,9,9,9-hendecamethylpentasiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7-octamethyltetrasiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7,9,9-decamethylpentasiloxane, 1-dimethylamino-1,3,3,5,5,7,7,7-octamethyltetrasiloxane, 1-dimethylamino-1,3,3,5,5,7,7,9,9,9-decamethylpentasiloxane, 1-dimethylamino-3,3,5,5,7,7,7-heptamethyltetrasiloxane, 1-dimethylamino-3,3,5,5,7,7,9,9,9-nonamethylpentasiloxane, 1-dimethylamino-1,3,5,7,7,7-hexamethyltetrasiloxane, and 1-dimethylamino-1,3,5,7,9,9,9-heptamethylpentasiloxane.

9. A method for making an organoamino-functionalized oligosiloxane compound selected from the group consisting of Formulae A and B:



A

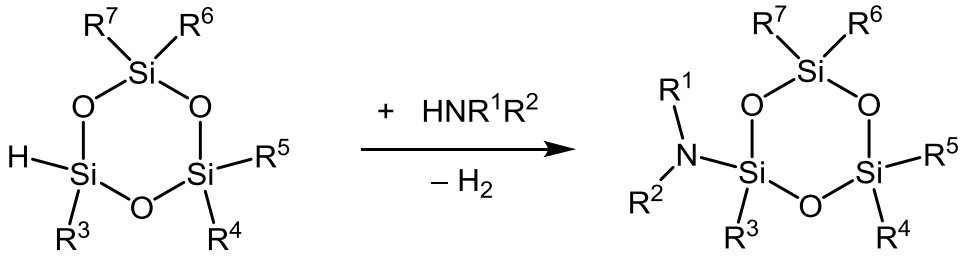


B

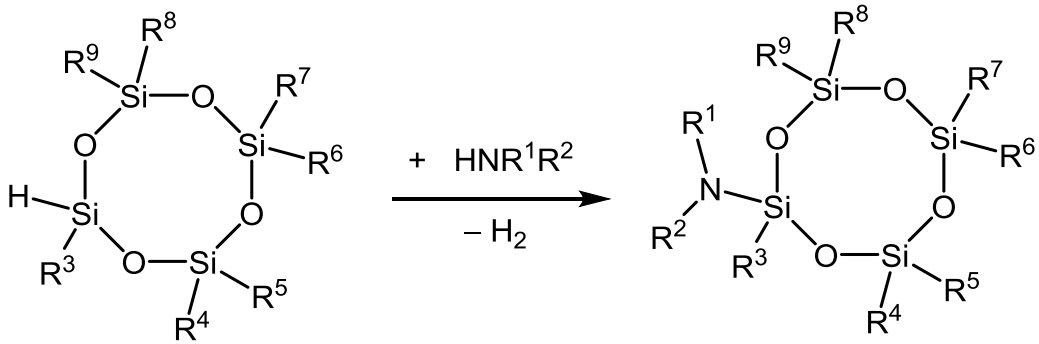
,

the method comprising the steps of:

reacting a cyclotrisiloxane of Formula (i) or a cyclotetrasiloxane compound of Formula (iii) with an organoamine in the presence of a catalyst as shown in equations (1) or (3):



(i) (A) (1)



(iii) (B) (3)

,

wherein

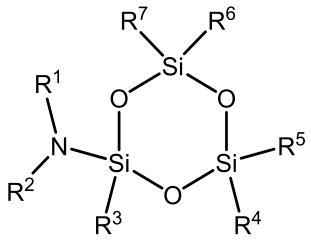
R^1 is selected from a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group;

R^2 is selected from the group consisting of hydrogen, a C_1 to C_{10} linear alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group, wherein R^1 and R^2 are either linked to form a cyclic ring structure or are not linked to form a cyclic ring structure; and

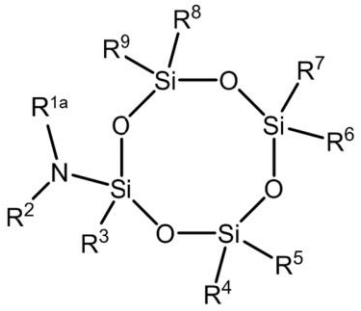
R^{3-9} are each independently selected from hydrogen, a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group.

10. The method of claim 9 wherein each of R^{2-9} is independently selected from hydrogen and a C_1 to C_4 alkyl group.

11. A method for making an organoamino-functionalized oligosiloxane compound selected from the group consisting of Formulae A and B:



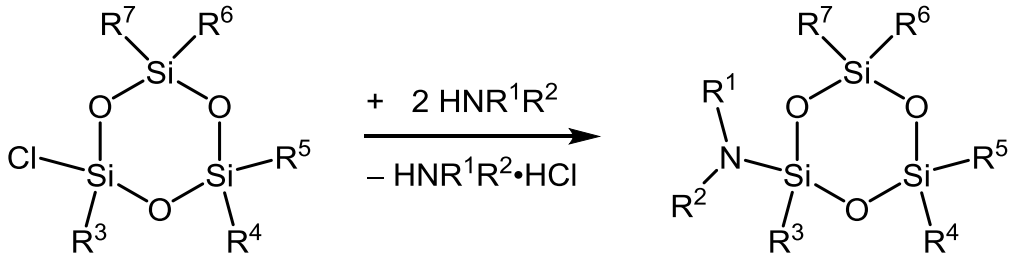
A



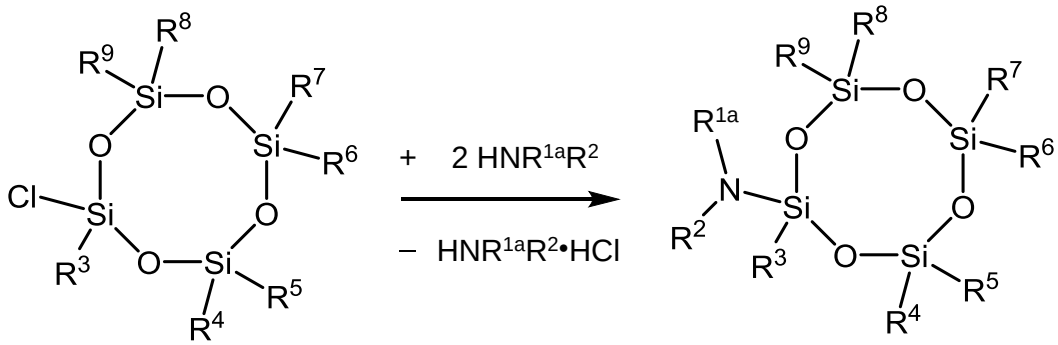
B ,

the method comprising the steps of:

reacting a chlorinated cyclotrisiloxane of Formula (ii) or a chlorinated cyclotetrasiloxane compound of Formula (iv) with an organoamine or metal salt of an organoamine as shown in equations (2) or (4):



(ii) (A) (2)



(iv) (B) (4)

,

wherein

R^1 is selected from a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, and a C_3 to C_{10} alkynyl group;

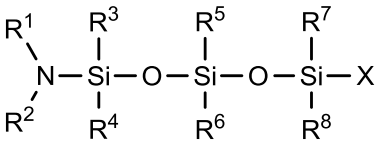
R^{1a} is selected from a linear C_2 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group;

R^2 is selected from the group consisting of hydrogen, a C_1 to C_{10} linear alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group, wherein R^1 and R^2 are either linked to form a cyclic ring structure or are not linked to form a cyclic ring structure, and wherein R^{1a} and R^2 are either linked to form a cyclic ring structure or are not linked to form a cyclic ring structure; and

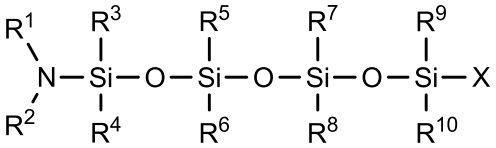
R^{3-9} are each independently selected from hydrogen, a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group.

12. The method of claim 11 wherein each of R^{2-9} is independently selected from hydrogen and a C_1 to C_4 alkyl group.

13. A method for making organoamino-functionalized oligosilaxane compounds selected from the group consisting of Formulae C and D:



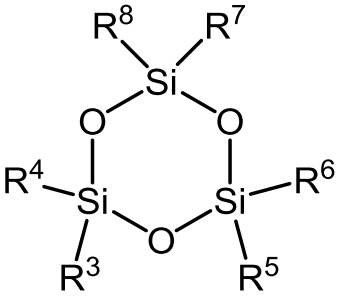
C



D

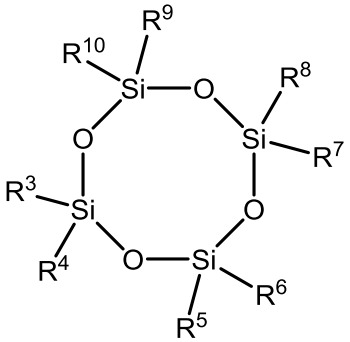
the method comprising the steps of:

reacting a compound of Formula (v) or Formula (vi)



(v)

or



(vi)

with a compound selected from the group consisting of acetyl chloride, methyl iodide, trimethylchlorosilane, dimethylchlorosilane, methylchlorosilane, monochlorosilane, and an organolithium compound to form an intermediate compound; and

thereafter reacting the intermediate compound with a compound selected from the group consisting of an organoaminochlorosilane, an organoamine, or chlorosilane, wherein

R^1 is selected from a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group;

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

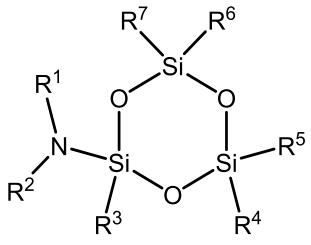
$R^{3\text{-}10}$ are each independently selected from hydrogen, a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group; and

X is selected from the group consisting of a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, a C_4 to C_{10} aryl group, a C_1 to C_{10} acyl group, an amine group (-NR^1R^2), H, Cl, Br, I, F, a C_2 to C_{12} carboxylate group, a C_1 to C_{10} linear or branched alkoxy group, a trimethylsiloxy group, a dimethylsiloxy group, a methylsiloxy group, and a siloxy group.

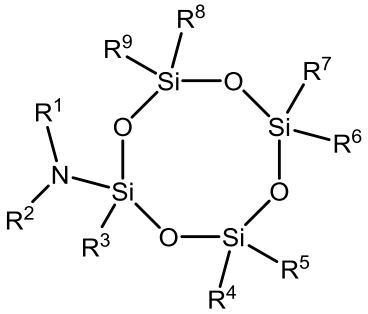
14. A method for depositing a film comprising silicon and oxygen onto a substrate, the method comprising the steps of:

a) providing a substrate in a reactor;

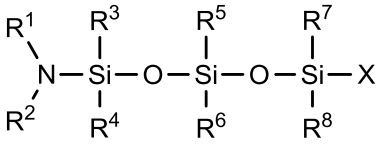
b) introducing into the reactor at least one silicon precursor compound selected from the group consisting of Formula A, B, C, D, and E



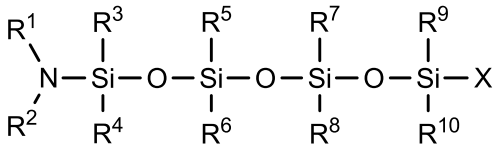
A



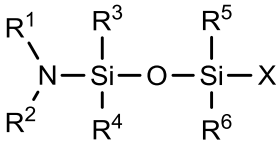
B



C



D



E

wherein

R^1 is selected from a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group;

R^2 is selected from the group consisting of hydrogen, a C_1 to C_{10} linear alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group, wherein R^1 and R^2 are either linked to form a cyclic ring structure or are not linked to form a cyclic ring structure; $R^{3\text{-}10}$ are each independently selected from hydrogen, a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group; X is selected from the group consisting of a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, a C_4 to C_{10} aryl group, a C_1 to C_{10} acyl group, an amine group ($-NR^1R^2$), H, Cl, Br, I, F, a C_2 to C_{12} carboxylate group, a C_1 to C_{10} linear or branched alkoxy group, a trimethylsiloxy group, a dimethylsiloxy group, a methylsiloxy group, or a siloxy group,wherein R^1 and X are either linked to form a cyclic ring or are not linked to form a cyclic ring;

c) purging the reactor with a purge gas;

d) introducing at least one of an oxygen-containing source and a nitrogen-containing source into the reactor; and

e) purging the reactor with the purge gas,

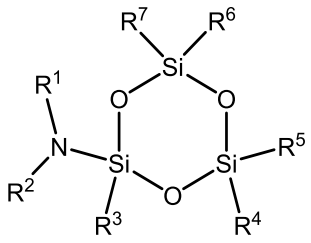
wherein the steps b through e are repeated until a desired thickness of film is deposited; and wherein the method is conducted at one or more temperatures ranging from about 25°C to 600°C.

15. The method of claim 14 wherein each of $R^{2\text{-}10}$ is independently selected from hydrogen and a C_1 to C_4 alkyl group.

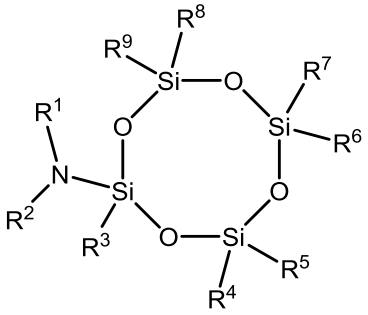
16. The method of claim 14, wherein the at least one silicon precursor compound is selected from the group consisting of 2-dimethylamino-2,4,4,6,6-pentamethylcyclotrisiloxane, 2-diethylamino-2,4,4,6,6-pentamethylcyclotrisiloxane, 2-ethylmethylamino-2,4,4,6,6-pentamethylcyclotrisiloxane, 2-iso-propylamino-2,4,4,6,6-pentamethylcyclotrisiloxane, 2-dimethylamino-2,4,4,6,6,8,8-heptamethylcyclotetrasiloxane, 2-diethylamino-2,4,4,6,6,8,8-heptamethylcyclotetrasiloxane, 2-ethylmethylamino-2,4,4,6,6,8,8-heptamethylcyclotetrasiloxane, 2-iso-propylamino-2,4,4,6,6,8,8-heptamethylcyclotetrasiloxane, 2-dimethylamino-2,4,6-trimethylcyclotrisiloxane, 2-diethylamino-2,4,6-trimethylcyclotrisiloxane, 2-ethylmethylamino-2,4,6-trimethylcyclotrisiloxane, 2-iso-propylamino-2,4,6-trimethylcyclotrisiloxane, 2-dimethylamino-2,4,6,8-tetramethylcyclotetrasiloxane, 2-diethylamino-2,4,6,8-tetramethylcyclotetrasiloxane, 2-ethylmethylamino-2,4,6,8-tetramethylcyclotetrasiloxane, and 2-iso-propylamino-2,4,6,8-tetramethylcyclotetrasiloxane.

17. The method of claim 14, wherein the at least one silicon precursor compound is selected from the group consisting of 1-dimethylamino-1,1,3,3,5,5-hexamethyl-5-methoxytrisiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7-octamethyl-7-methoxytrisiloxane, 1-dimethylamino-1,1,3,3,5,5-hexamethyl-5-acetoxytrisiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7-octamethyl-7-acetoxytrisiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7,7-nonamethyltetrasiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7,9,9,9-hendecamethylpentasiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7-octamethyltetrasiloxane, 1-dimethylamino-1,1,3,3,5,5,7,7,9,9-decamethylpentasiloxane, 1-dimethylamino-1,3,3,5,5,7,7,7-octamethyltetrasiloxane, 1-dimethylamino-1,3,3,5,5,7,7,9,9,9-decamethylpentasiloxane, 1-dimethylamino-3,3,5,5,7,7,7-heptamethyltetrasiloxane, 1-dimethylamino-3,3,5,5,7,7,9,9,9-nonamethylpentasiloxane, 1-dimethylamino-1,3,5,7,7,7-hexamethyltetrasiloxane, and 1-dimethylamino-1,3,5,7,9,9,9-heptamethylpentasiloxane.

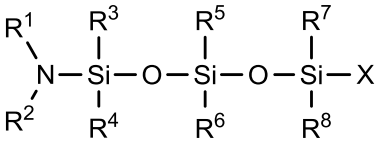
18. A silicon and oxygen containing film derived from at least one silicon precursor compound selected from the group consisting of Formulae A, B, C, D and E:



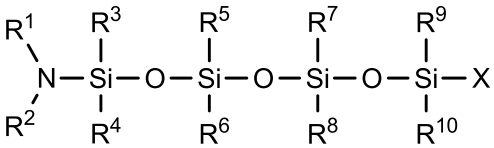
A



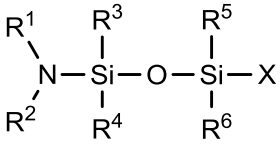
B



C



D



E

wherein

R^1 is selected from a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group;

R^2 is selected from the group consisting of hydrogen, a C_1 to C_{10} linear alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} heterocyclic group, a C_3 to C_{10} alkenyl group, a C_3 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group, wherein R^1 and R^2 are either linked to form a cyclic ring structure or are not linked to form a cyclic ring structure;

$R^{3\text{-}10}$ are each independently selected from hydrogen, a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, and a C_4 to C_{10} aryl group;

X is selected from the group consisting of a linear C_1 to C_{10} alkyl group, a branched C_3 to C_{10} alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_2 to C_{10} alkenyl group, a C_2 to C_{10} alkynyl group, a C_4 to C_{10} aryl group, a C_1 to C_{10} acyl group, an amine group ($-NR^1R^2$), H, Cl, Br, I, F, a C_2 to C_{12} carboxylate group, a C_1 to C_{10} linear or branched alkoxy group, a trimethylsiloxy group, a dimethylsiloxy group, a methylsiloxy group, or a siloxy group,

wherein R^1 and X are either linked to form a cyclic ring or are not linked to form a cyclic ring,

said film comprising at least one of the following characteristics: a density of at least about 2.1 g/cc; 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 dilute HF (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 5 e20 at/cc as measured by Secondary Ion Mass Spectrometry (SIMS).

19. A stainless steel container housing the composition of claim 1.

20. The stainless steel container of claim 19 further comprising an inert head-space gas selected from helium, argon, nitrogen and a combination thereof.

21. The method of claim 14 wherein the silicon precursor compound further comprising at least one selected from the group consisting of a solvent and an inert gas.