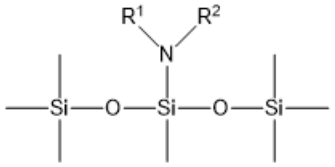
CLAIMS

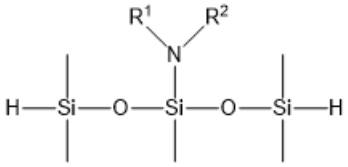
1. A method for depositing a silicon and oxygen containing film via flowable chemical vapor deposition (FCVD), the method comprising:

placing a substrate comprising a surface feature into a reactor wherein the substrate is maintained at one or more temperatures ranging from about -20°C to about 400°C and a pressure of the reactor is maintained at 100 torr or less;

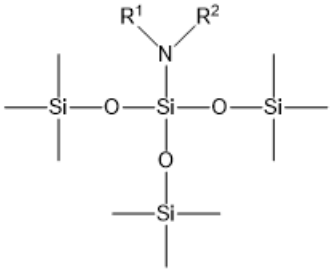
introducing into the reactor a composition comprising at least one organoamino-polysiloxane compound selected from the group consisting of Formulae A, B, C, D, E, F, G, and H:



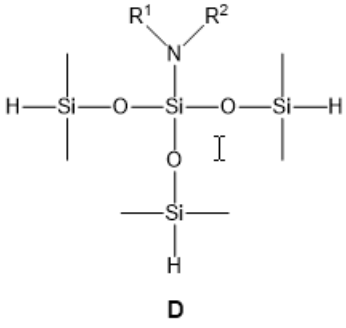
A ;



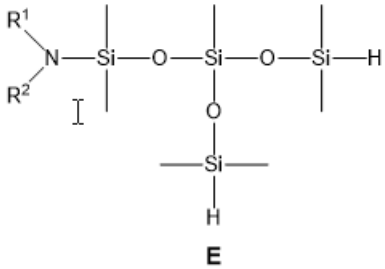
B ;



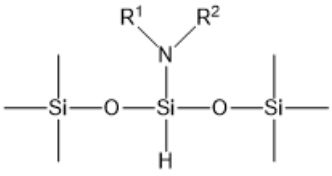
C ;



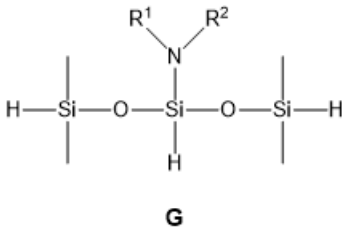
D ;



E ;

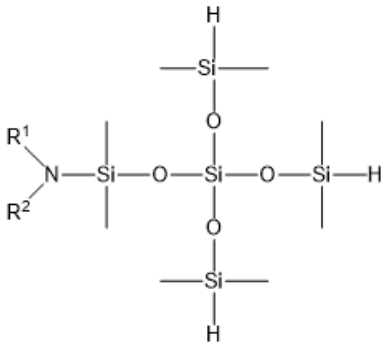


F ;



G

; and



H

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; and 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 in Formulae A-H are either linked to form a cyclic ring structure or are not linked to form a cyclic ring;

providing a first oxygen source into the reactor to react with the at least one organoamino-polysiloxane compound to form a film and cover at least a portion of the surface feature;

annealing the film at one or more temperatures of about 100°C to 1000°C to coat at least a portion of the surface feature; and

treating the substrate with a second oxygen source at one or more temperatures ranging from about 20°C to about 1000°C to form the silicon and oxygen containing film on at least a portion of the surface feature.

2. The method of claim 1, wherein the organoamino-polysiloxane compound is selected from the group consisting of 3-dimethylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3- diethylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3-ethylmethylamino-1,1,1,3,5,5,5- heptamethyltrisiloxane, 3-di-iso-propylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3- dimethylamino-1,1,3,5,5-pentamethyltrisiloxane, 3-diethylamino-1,1,3,5,5- pentamethyltrisiloxane, 3-ethylmethylamino-

1,1,3,5,5-pentamethyltrisiloxane, 3-di-iso- propylamino-1,1,3,5,5-pentamethyltrisiloxane, 3-dimethylamino-3-(trimethylsiloxy)- 1,1,1,5,5,5-hexamethyltrisiloxane, 3-diethylamino-3-(trimethylsiloxy)-1,1,1,5,5,5- hexamethyltrisiloxane, 3-ethylmethylamino-3-(trimethylsiloxy)-1,1,1,5,5,5- heptamethyltrisiloxane, 3-di-iso-propylaminoo-3-(trimethylsiloxy)-1,1,1,5,5,5-hexamethyltrisiloxane, 3-dimethylamino-3-(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 3-diethylamino-3-(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 3-ethylmethylamino-3-(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 3-di-iso-propylamino-3-(dimethylsiloxy)- 1,1,5,5-tetramethyltrisiloxane, 1-dimethylamino-3-(dimethylsiloxy)-1,1,3,5,5- pentamethyltrisiloxane, 1-diethylamino-3-(dimethylsiloxy)-1,1,3,5,5-pentamethyltrisiloxane, 1-ethylmethylamino-3-(dimethylsiloxy)-1,1,3,5,5-pentamethyltrisiloxane, 1-di-iso- propylamino-3-(dimethylsiloxy)-1,1,3,5,5-pentamethyltrisiloxane, 3-dimethylamino- 1,1,1,5,5,5-hexamethyltrisiloxane, 3-diethylamino-1,1,1,5,5,5-hexamethyltrisiloxane, 3- ethylmethylamino-1,1,1,5,5,5-hexamethyltrisiloxane, 3-di-iso-propylamino-1,1,1,3,5,5,5- hexamethyltrisiloxane, 3-dimethylamino-1,1,5,5-tetramethyltrisiloxane, 3-diethylamino- 1,1,5,5-tetramethyltrisiloxane, 3-ethylmethylamino-1,1,5,5-tetraamethyltrisiloxane, 3-di-iso- propylamino-1,1,5,5-tetramethyltrisiloxane, 1-dimethylamino-3,3-bis(dimethylsiloxy)-1,1,5,5- tetramethyltrisiloxane, 1-diethylamino-3,3-bis(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 1-ethylmethylamino-3,3-bis(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, and 1-di-iso- propylamino-3,3-bis(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 3-methylamino- 1,1,1,3,5,5,5-heptamethyltrisiloxane, 3-ethylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3- iso-propylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3-tert-butylamino-1,1,1,3,5,5,5- heptamethyltrisiloxane, 3-methylamino-3-(trimethylsiloxy)-1,1,1,5,5,5-hexamethyltrisiloxane, 3-ethylamino-3-(trimethylsiloxy)-1,1,1,5,5,5-hexamethyltrisiloxane, 3-iso-propylamino-3- (trimethylsiloxy)-1,1,1,5,5,5-hexamethyltrisiloxane, 3-tert-butylmino-3-(trimethylsiloxy)- 1,1,1,5,5,5-hexamethyltrisiloxane.

3. The method of claim 1, wherein R^1 and R^2 are each a C1 to C4 alkyl group.

4. The method of claim 1, wherein the first oxygen source is selected from the group consisting of water vapors, water plasma, ozone, oxygen, oxygen plasma, oxygen/helium plasma, oxygen/argon plasma, nitrogen oxides plasma, carbon dioxide plasma, hydrogen peroxide, organic peroxides, and mixtures thereof.

5. The method of claim 4, wherein the first oxygen source is water vapors, and further wherein the substrate is maintained from about -20°C to about 40°C.

6. The method of claim 5, wherein the substrate is maintained from about -10°C to about 25°C.

7. The method of claim 1, wherein the second oxygen source is selected from the group consisting of water vapors, water plasma, ozone, oxygen, oxygen plasma, oxygen/helium plasma, oxygen/argon plasma, nitrogen oxides plasma, carbon dioxide plasma, hydrogen peroxide, organic peroxides, and mixtures thereof.

8. The method of claim 1, wherein the composition further comprises at least one member selected from the group consisting of a solvent and a purge gas.

9. The method of claim 8, wherein the solvent is selected from the group consisting of hexamethyldisiloxane and octamethyltrisiloxane.

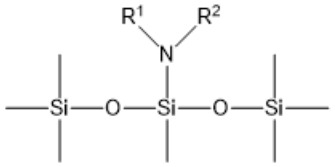
10. The method of claim 8, wherein the solvent is selected from the group consisting of hexane, heptane, octane, nonane, decane, dodecane, cyclooctane, cyclononane, cyclodecane, ethylcyclohexane, and ethylcyclooctane.

11. The method 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.

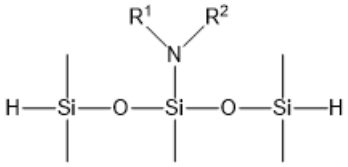
12. A method for depositing a silicon, oxygen, and nitrogen containing film via flowable chemical vapor deposition (FCVD), the method comprising:

placing a substrate comprising a surface feature into a reactor wherein the substrate is maintained at one or more temperatures ranging from about -20°C to about 400°C and a pressure of the reactor is maintained at 100 torr or less;

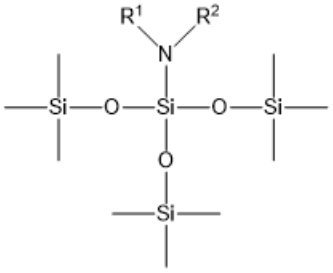
introducing into the reactor a composition comprising at least one organoamino-polysiloxane compound selected from the group consisting of Formulae A to H:



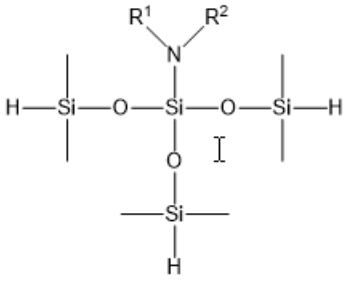
A ;



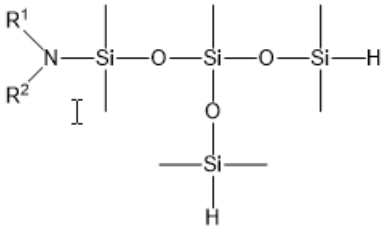
B ;



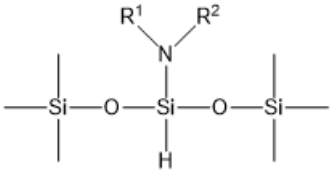
C ;



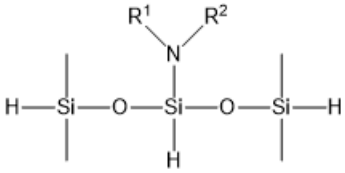
D ;



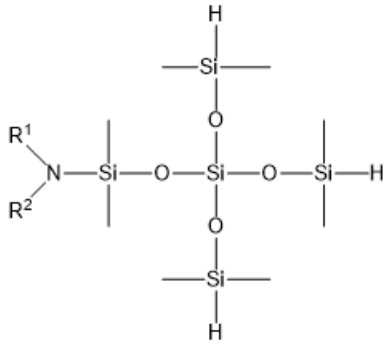
E ;



F ;



G ; and



H

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; and 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 in Formulae A-H are either linked to form a cyclic ring structure or are not linked to form a cyclic ring;

providing a nitrogen source into the reactor to react with the at least one organoamino-polysiloxane compound to form a film and cover at least a portion of the surface feature;

annealing the film at one or more temperatures of about 100°C to 1000°C to coat at least a portion of the surface feature; and

treating the substrate with an oxygen source at one or more temperatures ranging from about 20°C to about 1000°C to form the silicon, oxygen, and nitrogen containing film on at least a portion of the surface feature.

13. The method of claim 12, wherein the organoamino-polysiloxane compound is selected from the group consisting of 3-dimethylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3- diethylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3-ethylmethylamino-1,1,1,3,5,5,5- heptamethyltrisiloxane, 3-di-iso-propylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3- dimethylamino-1,1,3,5,5-pentamethyltrisiloxane, 3-diethylamino-1,1,3,5,5- pentamethyltrisiloxane, 3-ethylmethylamino-1,1,3,5,5-pentamethyltrisiloxane, 3-di-iso- propylamino-1,1,3,5,5-pentamethyltrisiloxane, 3-dimethylamino-3-(trimethylsiloxy)- 1,1,1,5,5,5-hexamethyltrisiloxane, 3-diethylamino-3-(trimethylsiloxy)-1,1,1,5,5,5- hexamethyltrisiloxane, 3-ethylmethylamino-3-(trimethylsiloxy)-1,1,1,5,5,5- heptamethyltrisiloxane, 3-di-iso-propylaminoo-3-(trimethylsiloxy)-1,1,1,5,5,5-hexamethyltrisiloxane, 3-dimethylamino-3-(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 3-diethylamino-3-(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 3-ethylmethylamino-3-(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 3-di-iso-propylamino-3-(dimethylsiloxy)- 1,1,5,5-tetramethyltrisiloxane, 1-dimethylamino-3-(dimethylsiloxy)-1,1,3,5,5- pentamethyltrisiloxane, 1-diethylamino-3-(dimethylsiloxy)-1,1,3,5,5-pentamethyltrisiloxane, 1-ethylmethylamino-3-(dimethylsiloxy)-1,1,3,5,5-pentamethyltrisiloxane, 1-di-iso- propylamino-3-(dimethylsiloxy)-1,1,3,5,5-pentamethyltrisiloxane, 3-dimethylamino- 1,1,1,5,5,5-hexamethyltrisiloxane, 3-diethylamino-1,1,1,5,5,5-hexamethyltrisiloxane, 3- ethylmethylamino-1,1,1,5,5,5-hexamethyltrisiloxane, 3-di-iso-propylamino-1,1,1,3,5,5,5- hexamethyltrisiloxane, 3-dimethylamino-1,1,5,5-tetramethyltrisiloxane, 3-diethylamino- 1,1,5,5-tetramethyltrisiloxane, 3-

ethylmethylamino-1,1,5,5-tetraamethyltrisiloxane, 3-di-iso- propylamino-1,1,5,5-tetramethyltrisiloxane, 1-dimethylamino-3,3-bis(dimethylsiloxy)-1,1,5,5- tetramethyltrisiloxane, 1-diethylamino-3,3-bis(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 1-ethylmethylamino-3,3-bis(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, and 1-di-iso- propylamino-3,3-bis(dimethylsiloxy)-1,1,5,5-tetramethyltrisiloxane, 3-methylamino- 1,1,1,3,5,5,5-heptamethyltrisiloxane, 3-ethylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3- iso-propylamino-1,1,1,3,5,5,5-heptamethyltrisiloxane, 3-tert-butylamino-1,1,1,3,5,5,5- heptamethyltrisiloxane, 3-methylamino-3-(trimethylsiloxy)-1,1,1,5,5,5-hexamethyltrisiloxane, 3-ethylamino-3-(trimethylsiloxy)-1,1,1,5,5,5-hexamethyltrisiloxane, 3-iso-propylamino-3- (trimethylsiloxy)-1,1,1,5,5,5-hexamethyltrisiloxane, 3-tert-butylmino-3-(trimethylsiloxy)- 1,1,1,5,5,5-hexamethyltrisiloxane.

14. The method of claim 12, wherein R^1 and R^2 are each a C1 to C4 alkyl group.

15. The method of claim 12, wherein the nitrogen source is selected from the group consisting of ammonia, hydrazine, monoalkylhydrazine, dialkylhydrazine, nitrogen, nitrogen/hydrogen, nitrogen/argon plasma, nitrogen/helium plasma, ammonia plasma, nitrogen plasma, nitrogen/hydrogen plasma, organic amines such as tert-butylamine, dimethylamine, diethylamine, isopropylamine, diethylamine plasma, dimethylamine plasma, trimethyl plasma, trimethylamine plasma, ethylenediamine plasma, and an alkoxyamine such as ethanolamine plasma, and mixtures thereof.

16. The method of claim 12, wherein the oxygen source is selected from the group consisting of water vapors, water plasma, ozone, oxygen, oxygen plasma, oxygen/helium plasma, oxygen/argon plasma, nitrogen oxides plasma, carbon dioxide plasma, hydrogen peroxide, organic peroxides, and mixtures thereof.

17. The method of claim 12, wherein the composition further comprises at least one member selected from the group consisting of a solvent and a purge gas.

18. The method of claim 19, wherein the solvent is selected from the group consisting of hexamethyldisiloxane and octamethyltrisiloxane.

19. The method of claim 19, wherein the solvent is selected from the group consisting of hexane, heptane, octane, nonane, decane, dodecane, cyclooctane, cyclononane, cyclodecane, ethylcyclohexane, and ethylcyclooctane.

20. The method of claim 12, 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.