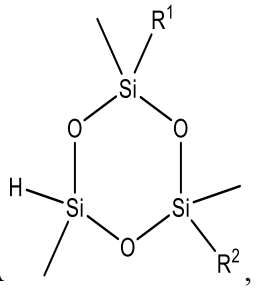
CLAIMS

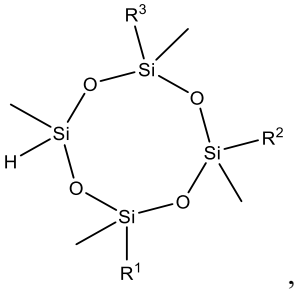
What is claimed is:

1. A composition when used in depositing a silicon-containing film via Flowable Chemical Vapor Deposition (FCVD), comprising:

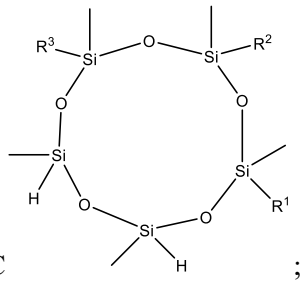
an alkoxy-functionalized cyclosiloxane compound depicted by Formulas A, B, or C,



A ,



B , or



C ;

wherein R^1 is an alkoxy-group having 1 to 10 carbon atoms;

wherein R^2 is H, or is an alkoxy-group having 1 to 10 carbon atoms; and

wherein R^3 is H, or is an alkoxy-group having 1 to 10 carbon atoms.

2. The composition according to claim 1, wherein R^1 is an alkoxy-group selected from the group consisting of a methoxy, an ethoxy, a 1-propoxy, an isopropoxy, a 1-butoxy, a tert-butoxy, a sec-butoxy, a 1-pentoxy, a 2-pentoxy, a 3-pentoxy, a 2-methyl-1-butoxy, a 3-methyl-1-butoxy, a 2-methyl-2-butoxy, a 2-methyl-3-butoxy, a 2,2-dimethyl-1-propoxy, a 1-hexoxy, a 2-hexoxy, a 3-hexoxy, a 2-methyl-1-pentoxy, a 3-methyl-1-pentoxy, a 4-methyl-1-pentoxy, a 2-methyl-2-pentoxy, a 3-methyl-2-pentoxy, a 4-methyl-2-pentoxy, a 2-methyl-3-pentoxy, a 3-methyl-3-pentoxy, a 2,2-dimethyl-1-butoxy, a 2,3-dimethyl-1-butoxy, a 2,3-dimethyl-2-butoxy, a 3,3,-dimethyl-2-butoxy, a 2-ethyl-1-butoxy, a cyclopentoxy, a cyclohexoxy, and combinations thereof, wherein R^2 is H, and wherein R^3 is H.

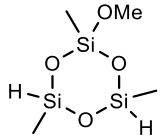
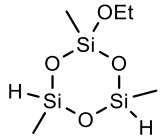
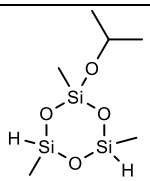
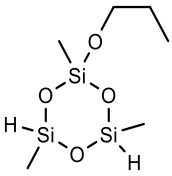
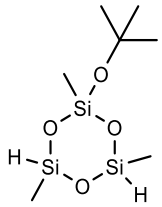
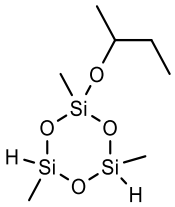
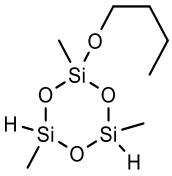
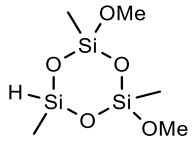
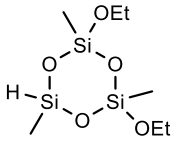
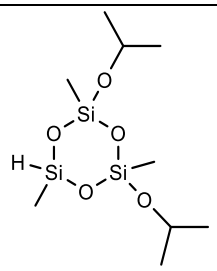
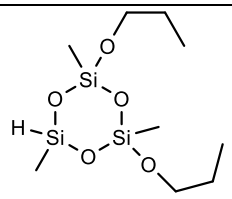
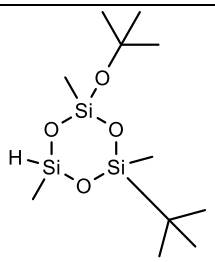
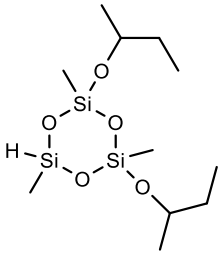
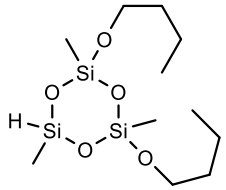
3. The composition according to claim 1, wherein R^1 is an alkoxy-group selected from the group consisting of a methoxy, an ethoxy, a 1-propoxy, an isopropoxy, a 1-butoxy, a tert-butoxy, a sec-butoxy, a 1-pentoxy, a 2-pentoxy, a 3-pentoxy, a 2-methyl-1-butoxy, a 3-methyl-1-butoxy, a 2-methyl-2-butoxy, a 2-methyl-3-butoxy, a 2,2-dimethyl-1-propoxy, a 1-hexoxy, a 2-hexoxy, a 3-hexoxy, a 2-methyl-1-pentoxy, a 3-methyl-1-pentoxy, a 4-methyl-1-pentoxy, a 2-methyl-2-pentoxy, a 3-methyl-2-pentoxy, a 4-methyl-2-pentoxy, a 2-methyl-3-pentoxy, a 3-methyl-3-pentoxy, a 2,2-dimethyl-1-butoxy, a 2,3-dimethyl-1-butoxy, a 2,3-dimethyl-2-butoxy, a 3,3,-dimethyl-2-butoxy, a 2-ethyl-1-butoxy, a cyclopentoxy, a cyclohexoxy, and combinations thereof, wherein R^2 is an alkoxy-group selected from the group consisting of a methoxy, an ethoxy, a 1-propoxy, an isopropoxy, a 1-butoxy, a tert-butoxy, a sec-butoxy, a 1-pentoxy, a 2-pentoxy, a 3-pentoxy, a 2-methyl-1-butoxy, a 3-methyl-1-butoxy, a 2-methyl-2-butoxy, a 2-methyl-3-butoxy, a 2,2-dimethyl-1-propoxy, a 1-hexoxy, a 2-hexoxy, a 3-hexoxy, a 2-methyl-1-pentoxy, a 3-methyl-1-pentoxy, a 4-methyl-1-pentoxy, a 2-methyl-2-pentoxy, a 3-methyl-2-pentoxy, a 4-methyl-2-pentoxy, a 2-methyl-3-pentoxy, a 3-methyl-3-pentoxy, a 2,2-dimethyl-1-butoxy, a 2,3-dimethyl-1-butoxy, a 2,3-dimethyl-2-butoxy, a 3,3,-dimethyl-2-butoxy, a 2-ethyl-1-butoxy, a cyclopentoxy, a cyclohexoxy, and combinations thereof, and wherein R^3 is H.

4. The composition according to claim 1, wherein R^1 is an alkoxy-group selected from the group consisting of a methoxy, an ethoxy, a 1-propoxy, an isopropoxy, a 1-butoxy, a tert-butoxy, a sec-butoxy, a 1-pentoxy, a 2-pentoxy, a 3-pentoxy, a 2-methyl-1-butoxy, a 3-methyl-1-butoxy, a 2-methyl-2-butoxy, a 2-methyl-3-butoxy, a 2,2-dimethyl-1-propoxy, a 1-hexoxy, a 2-hexoxy, a 3-hexoxy, a 2-methyl-1-pentoxy, a 3-methyl-1-pentoxy, a 4-methyl-1-pentoxy, a 2-methyl-2-pentoxy, a 3-methyl-2-pentoxy, a 4-methyl-2-pentoxy, a 2-methyl-3-pentoxy, a 3-methyl-3-pentoxy, a 2,2-dimethyl-1-butoxy, a 2,3-dimethyl-1-butoxy, a 2,3-dimethyl-2-butoxy, a 3,3,-dimethyl-2-butoxy, a 2-ethyl-1-butoxy, a cyclopentoxy, a cyclohexoxy, and combinations thereof, wherein R^2 is H, and wherein R^3 is an alkoxy-group selected from the group consisting of a methoxy, an ethoxy, a 1-propoxy, an isopropoxy, a 1-butoxy, a tert-butoxy, a sec-butoxy, a 1-pentoxy, a 2-pentoxy, a 3-

pentoxy, a 2-methyl-1-butoxy, a 3-methyl-1-butoxy, a 2-methyl-2-butoxy, a 2-methyl-3-butoxy, a 2,2-dimethyl-1-propoxy, a 1-hexoxy, a 2-hexoxy, a 3-hexoxy, a 2-methyl-1-pentoxy, a 3-methyl-1-pentoxy, a 4-methyl-1-pentoxy, a 2-methyl-2-pentoxy, a 3-methyl-2-pentoxy, a 4-methyl-2-pentoxy, a 2-methyl-3-pentoxy, a 3-methyl-3-pentoxy, a 2,2-dimethyl-1-butoxy, a 2,3-dimethyl-1-butoxy, a 2,3-dimethyl-2-butoxy, a 3,3,-dimethyl-2-butoxy, a 2-ethyl-1-butoxy, a cyclopentoxy, a cyclohexoxy, and combinations thereof.

5. The composition according to claim 1, wherein R^1 is an alkoxy-group selected from the group consisting of a methoxy, an ethoxy, a 1-propoxy, an isopropoxy, a 1-butoxy, a tert-butoxy, a sec-butoxy, a 1-pentoxy, a 2-pentoxy, a 3-pentoxy, a 2-methyl-1-butoxy, a 3-methyl-1-butoxy, a 2-methyl-2-butoxy, a 2-methyl-3-butoxy, a 2,2-dimethyl-1-propoxy, a 1-hexoxy, a 2-hexoxy, a 3-hexoxy, a 2-methyl-1-pentoxy, a 3-methyl-1-pentoxy, a 4-methyl-1-pentoxy, a 2-methyl-2-pentoxy, a 3-methyl-2-pentoxy, a 4-methyl-2-pentoxy, a 2-methyl-3-pentoxy, a 3-methyl-3-pentoxy, a 2,2-dimethyl-1-butoxy, a 2,3-dimethyl-1-butoxy, a 2,3-dimethyl-2-butoxy, a 3,3,-dimethyl-2-butoxy, a 2-ethyl-1-butoxy, a cyclopentoxy, a cyclohexoxy, and combinations thereof, wherein R^2 is an alkoxy-group selected from the group consisting of a methoxy, an ethoxy, a 1-propoxy, an isopropoxy, a 1-butoxy, a tert-butoxy, a sec-butoxy, a 1-pentoxy, a 2-pentoxy, a 3-pentoxy, a 2-methyl-1-butoxy, a 3-methyl-1-butoxy, a 2-methyl-2-butoxy, a 2-methyl-3-butoxy, a 2,2-dimethyl-1-propoxy, a 1-hexoxy, a 2-hexoxy, a 3-hexoxy, a 2-methyl-1-pentoxy, a 3-methyl-1-pentoxy, a 4-methyl-1-pentoxy, a 2-methyl-2-pentoxy, a 3-methyl-2-pentoxy, a 4-methyl-2-pentoxy, a 2-methyl-3-pentoxy, a 3-methyl-3-pentoxy, a 2,2-dimethyl-1-butoxy, a 2,3-dimethyl-1-butoxy, a 2,3-dimethyl-2-butoxy, a 3,3,-dimethyl-2-butoxy, a 2-ethyl-1-butoxy, a cyclopentoxy, a cyclohexoxy, and combinations thereof, and wherein R^3 is an alkoxy-group selected from the group consisting of a methoxy, an ethoxy, a 1-propoxy, an isopropoxy, a 1-butoxy, a tert-butoxy, a sec-butoxy, a 1-pentoxy, a 2-pentoxy, a 3-pentoxy, a 2-methyl-1-butoxy, a 3-methyl-1-butoxy, a 2-methyl-2-butoxy, a 2-methyl-3-butoxy, a 2,2-dimethyl-1-propoxy, a 1-hexoxy, a 2-hexoxy, a 3-hexoxy, a 2-methyl-1-pentoxy, a 3-methyl-1-pentoxy, a 4-methyl-1-pentoxy, a 2-methyl-2-pentoxy, a 3-methyl-2-pentoxy, a 4-methyl-2-pentoxy, a 2-methyl-3-pentoxy, a 3-methyl-3-pentoxy, a 2,2-dimethyl-1-butoxy, a 2,3-dimethyl-1-butoxy, a 2,3-dimethyl-2-butoxy, a 3,3,-dimethyl-2-butoxy, a 2-ethyl-1-butoxy, a cyclopentoxy, a cyclohexoxy, and combinations thereof.

6. The composition according to claim 1, wherein the alkoxy-functionalized cyclosiloxane compound is selected from the group consisting of:

 2-methoxy-2,4,6-trimethylcyclotrisiloxane	 2-ethoxy-2,4,6-trimethylcyclotrisiloxane	 2-isopropoxy-2,4,6-trimethylcyclotrisiloxane
 2-propoxy-2,4,6-trimethylcyclotrisiloxane	 2-t-butoxy-2,4,6-trimethylcyclotrisiloxane	 2-sec-butoxy-2,4,6-trimethylcyclotrisiloxane
 2-butoxy-2,4,6-trimethylcyclotrisiloxane	 2,4-dimethoxy-2,4,6-trimethylcyclotrisiloxane	 2,4-diethoxy-2,4,6-trimethylcyclotrisiloxane
 2,4-diisopropoxy-2,4,6-trimethylcyclotrisiloxane	 2,4-dipropoxy-2,4,6-trimethylcyclotrisiloxane	 2,4-di-t-butoxy-2,4,6-trimethylcyclotrisiloxane
 2,4-di-sec-butoxy-2,4,6-trimethylcyclotrisiloxane	 2,4-dibutoxy-2,4,6-trimethylcyclotrisiloxane	

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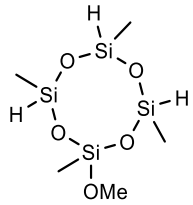
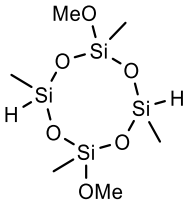
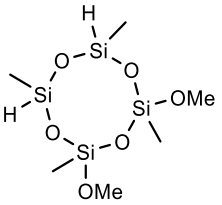
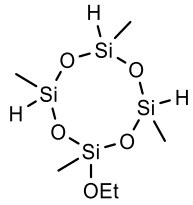
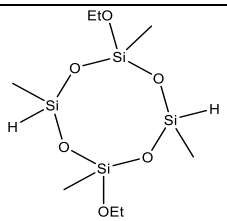
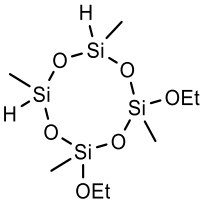
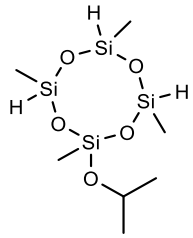
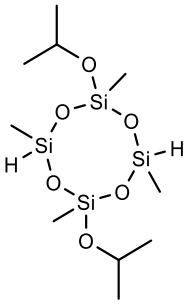
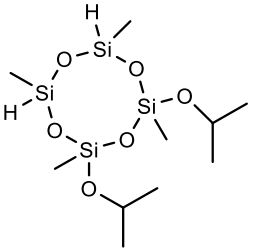
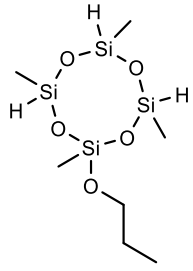
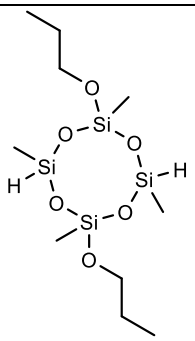
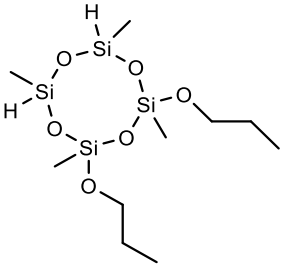
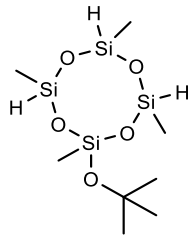
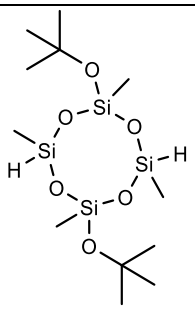
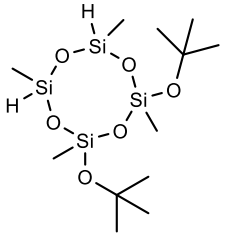
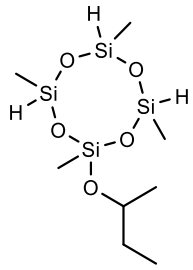
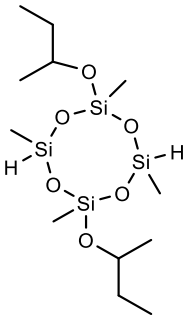
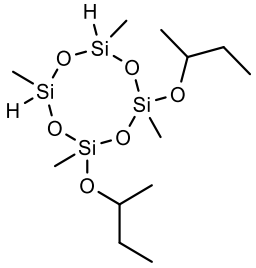
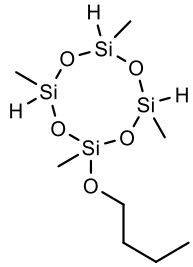
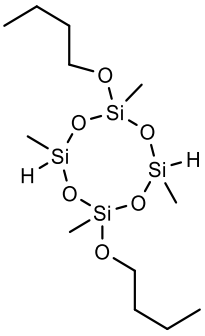
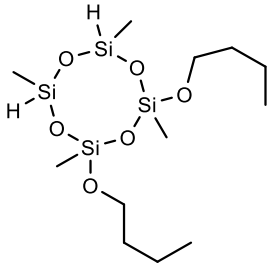
7. The composition according to claim 1, wherein the alkoxy-functionalized cyclosiloxane compound is selected from the group consisting of:

 2-methoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,6-dimethoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,4-dimethoxy-2,4,6,8-tetramethylcyclotetrasiloxane
 2-ethoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,6-diethoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,4-diethoxy-2,4,6,8-tetramethylcyclotetrasiloxane
 2-isopropoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,6-diisopropoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,4-diisopropoxy-2,4,6,8-tetramethylcyclotetrasiloxane
 2-propoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,6-dipropoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,4-dipropoxy-2,4,6,8-tetramethylcyclotetrasiloxane

 2-t-butoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,6-di-t-butoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,4-di-t-butoxy-2,4,6,8-tetramethylcyclotetrasiloxane
 2-sec-butoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,6-di-sec-butoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,4-di-sec-butoxy-2,4,6,8-tetramethylcyclotetrasiloxane
 2-butoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,6-dibutoxy-2,4,6,8-tetramethylcyclotetrasiloxane	 2,4-dibutoxy-2,4,6,8-tetramethylcyclotetrasiloxane

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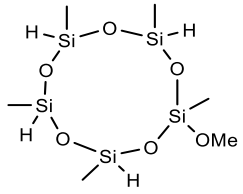
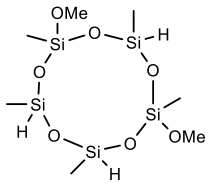
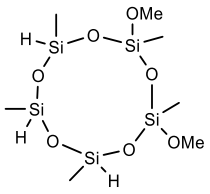
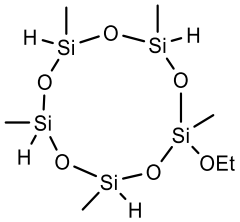
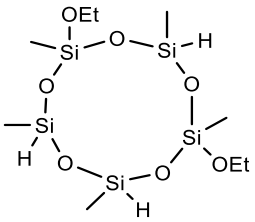
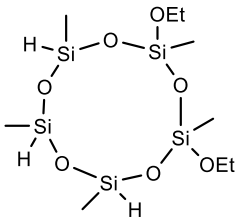
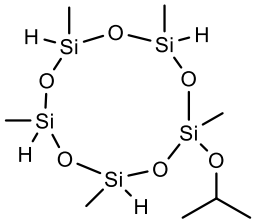
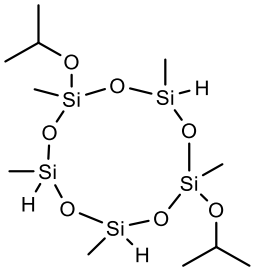
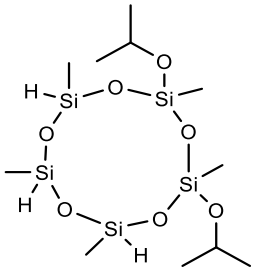
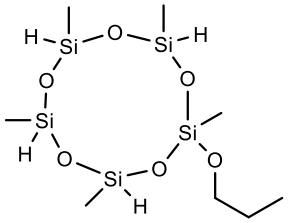
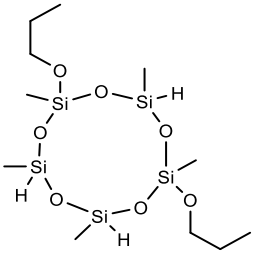
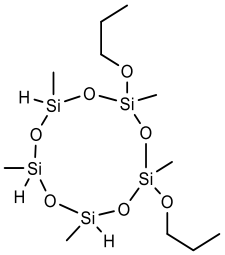
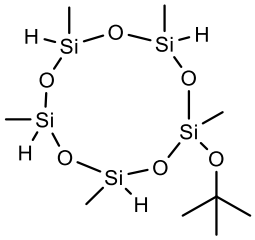
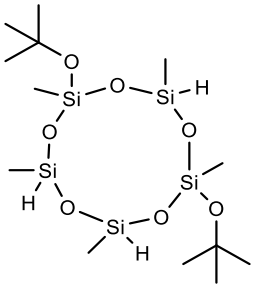
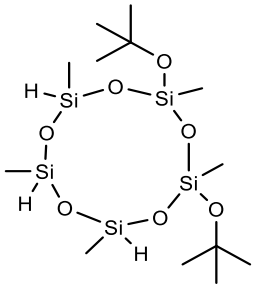
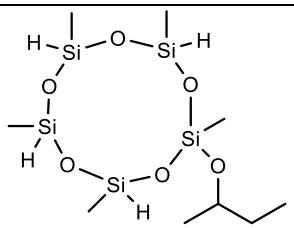
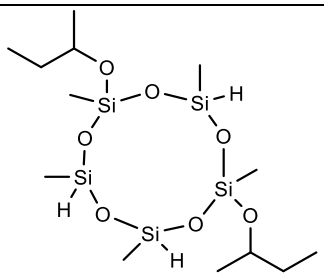
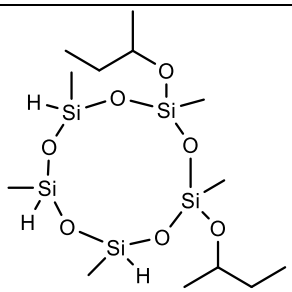
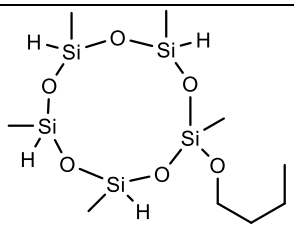
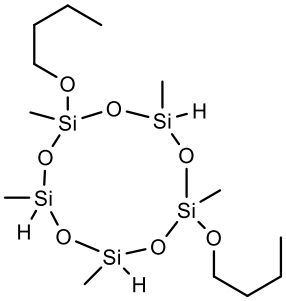
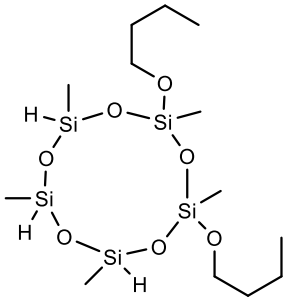
8. The composition according to claim 1, wherein the alkoxy-functionalized cyclosiloxane compound is selected from the group consisting of:

2-methoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	2,6-dimethoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	2,4-dimethoxy-2,4,6,8,10-pentamethylcyclopentasiloxane
 2-ethoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,6-diethoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,4-diethoxy-2,4,6,8,10-pentamethylcyclopentasiloxane
 2-isopropoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,6-diisopropoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,4-diisopropoxy-2,4,6,8,10-pentamethylcyclopentasiloxane
 2-propoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,6-dipropoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,4-dipropoxy-2,4,6,8,10-pentamethylcyclopentasiloxane
		

2-t-butoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	2,6-di-t-butoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	2,4-di-t-butoxy-2,4,6,8,10-pentamethylcyclopentasiloxane
 2-sec-butoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,6-di-sec-butoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,4-di-sec-butoxy-2,4,6,8,10-pentamethylcyclopentasiloxane
 2-butoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,6-dibutoxy-2,4,6,8,10-pentamethylcyclopentasiloxane	 2,4-dibutoxy-2,4,6,8,10-pentamethylcyclopentasiloxane

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9. The composition according to claim 1, comprising a mixture of compounds of Formula A and Formula B.

10. The composition according to claim 1, comprising a mixture of compounds of Formula A and Formula C.

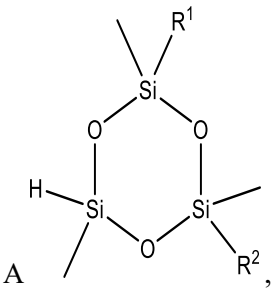
11 The composition according to claim 1, comprising a mixture of compounds of Formula B and Formula C.

12. The composition according to claim 1, comprising a mixture of compounds of Formula A, Formula B, and Formula C.

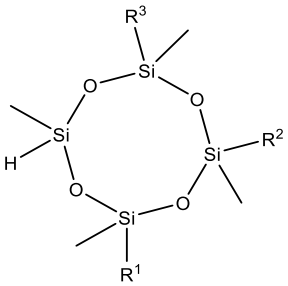
13. A method of depositing a silicon-containing film, comprising:

placing a substrate comprising a surface feature into a deposition chamber;

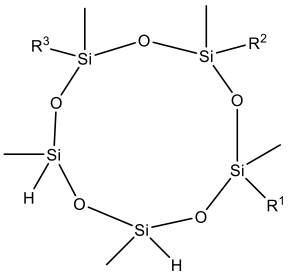
introducing two, or more, molecules of an alkoxy-functionalized cyclosiloxane compound represented by the Formulas A, B, or C, into the deposition chamber,



A ,



B , or



C ,

wherein R^1 is an alkoxy-group having 1 to 10 carbon atoms,

wherein R^2 is H, or is an alkoxy-group having 1 to 10 carbon atoms, and

wherein R^3 is H, or is an alkoxy-group having 1 to 10 carbon atoms;

exposing the two, or more, molecules of the alkoxy-functionalized cyclosiloxane compound represented by Formulas A, B, or C, to a plasma in the deposition chamber, thereby inducing

a reaction between the two, or more, molecules and thus creating a flowable liquid, or oligomer, made from the two, or more, molecules of the alkoxy-functionalized cyclosiloxane compound represented by Formulas A, B, or C;

permitting the flowable liquid, or oligomer, to at least partially fill the surface feature and thus create the silicon-containing film.

14. The method of depositing a silicon-containing film according to claim 13, wherein the introducing step further comprises introducing an inert gas into the deposition chamber, wherein the inert gas is selected from the group consisting of helium, argon, xenon, and mixtures thereof, wherein the plasma in the exposing step is an in-situ plasma, and wherein atoms of the inert gas are not incorporated into the into the flowable liquid, or oligomer, made from the two, or more, molecules of the alkoxy-functionalized cyclosiloxane compound represented by the Formulas A, B or C, by exposure to the in-situ plasma in the deposition chamber, thereby creating a silicon-containing film comprising silicon and carbon.

15. The method of depositing a silicon-containing film according to claim 13, wherein the introducing step further comprises introducing a nitrogen source into the deposition chamber, wherein the nitrogen source is selected from the group consisting of N_2, ammonia, NF_3, an organoamine, and mixtures thereof, wherein the plasma in the exposing step is an in-situ plasma, and wherein nitrogen atoms of the nitrogen source are incorporated into the flowable liquid, or oligomer, made from the two, or more, molecules of the alkoxy-functionalized cyclosiloxane compound represented by the Formulas A, B or C, by exposure to the in-situ plasma in the deposition chamber, thereby creating a silicon-containing film comprising silicon, carbon, and nitrogen.

16. The method of depositing a silicon-containing film according to claim 13, wherein the introducing step further comprises introducing an oxygen source selected from the group consisting of water, oxygen, ozone, nitric oxide, nitrous oxide, carbon monoxide, carbon dioxide, and combinations thereof, wherein the plasma in the exposing step is an in-situ plasma, and wherein oxygen atoms of the oxygen source are incorporated into the flowable liquid, or oligomer, made from the two, or more, molecules of the alkoxy-functionalized cyclosiloxane compound represented by the Formulas A, B or C, by exposure to the in-situ plasma in the deposition chamber, thereby creating a silicon-containing film comprising silicon, carbon, and oxygen.

17. The method of depositing a silicon-containing film according to claim 13, wherein the plasma in the exposing step is a remote plasma comprising an inert gas, wherein the inert gas is selected from

the group consisting of helium, argon, xenon, and mixtures thereof, and wherein atoms of the inert gas are not incorporated into the into the flowable liquid, or oligomer, made from the two, or more, molecules of the alkoxy-functionalized cyclosiloxane compound represented by the Formulas A, B or C, after exposure to the remote plasma in the deposition chamber, thereby creating a silicon-containing film comprising silicon and carbon.

18. The method of depositing a silicon-containing film according to claim 13, wherein the plasma in the exposing step is a remote plasma comprising a nitrogen source, wherein the nitrogen source is selected from the group consisting of N_2, ammonia, NF_3, an organoamine, and mixtures thereof, and wherein nitrogen atoms of the nitrogen source are incorporated into the flowable liquid, or oligomer, made from the two, or more, molecules of the alkoxy-functionalized cyclosiloxane compound represented by the Formulas A, B or C, after exposure to the remote plasma in the deposition chamber, thereby creating a silicon-containing film comprising silicon, carbon, and nitrogen.

19. The method of depositing a silicon-containing film according to claim 13, wherein the plasma in the exposing step is a remote plasma comprising an oxygen source, wherein the oxygen source is selected from the group consisting of water, oxygen, ozone, nitric oxide, nitrous oxide, carbon monoxide, carbon dioxide, and combinations thereof, and wherein oxygen atoms of the oxygen source are incorporated into the flowable liquid, or oligomer, made from the two, or more, molecules of the alkoxy-functionalized cyclosiloxane compound represented by the Formulas A, B or C, after exposure to the remote plasma in the deposition chamber, thereby creating a silicon-containing film comprising silicon, carbon, and oxygen.

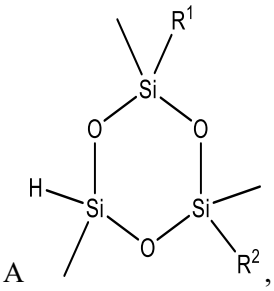
20. The method of depositing a silicon-containing film according to claim 13, wherein the substrate is pre-treated in a pre-treatment step before placing it into the deposition chamber, and wherein the pre-treatment step is selected from the group consisting of a plasma treatment, a thermal treatment, a chemical treatment, exposure to ultraviolet light, exposure to an electron beam, and combinations thereof.

21. The method of depositing a silicon-containing film according to claim 13, further comprising a post-treatment in a post-treatment step, and wherein the post-treatment is selected from the group consisting of an ultraviolet cure of the silicon-containing film, a plasma annealing of the silicon-containing film, an infrared treatment of the silicon-containing film, a thermal annealing of the silicon-containing film in non-oxygenated environment, a thermal annealing of the silicon-containing

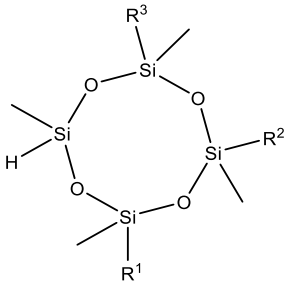
film in an oxygenated environment, and combinations thereof, thereby densifying the silicon-containing film.

22. A film on a substrate, comprising:

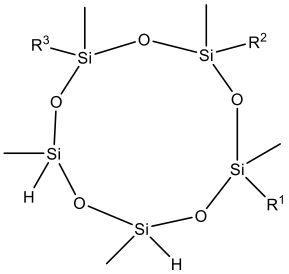
a flowable liquid, or oligomer, comprising two, or more, oligomerized, or polymerized, molecules of an alkoxy-functionalized cyclosiloxane compound depicted by Formulas A, B, or C,



A ,



B , or



C ;

wherein R^1 is an alkoxy-group having 1 to 10 carbon atoms;

wherein R^2 is H, or is an alkoxy-group having 1 to 10 carbon atoms; and

wherein R^3 is H, or is an alkoxy-group having 1 to 10 carbon atoms.