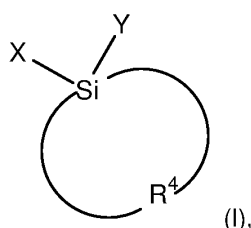


## CLAIMS

1. A method for producing a dielectric film represented by the formula  $\text{Si}_v\text{O}_w\text{C}_x\text{H}_y\text{F}_z$ , where  $v+w+x+y+z = 100\%$ ,  $v$  is from 10 to 35 atomic%,  $w$  is from 10 to 65 atomic%,  $x$  is from 5 to 40 atomic%,  $y$  is from 10 to 50 atomic% and  $z$  is from 0 to 15 atomic%, said method comprising:
- providing a substrate within a reaction chamber;
- introducing into the reaction chamber gaseous reagents including at least one structure-forming precursor comprising an alkoxysilacyclic or an acyloxysilacyclic compound, and a porogen, wherein the alkoxysilacyclic or the acyloxysilacyclic compound has a structure represented by Formula I:



- wherein  $X$  and  $Y$  are independently selected from the group consisting of  $\text{OR}^1$ ,  $\text{OR}^2$ , and  $\text{OC(O)R}^3$ , wherein  $\text{R}^{1-3}$  are each independently selected from the group consisting of a linear or branched  $\text{C}_1$  to  $\text{C}_{10}$  alkyl group, a linear or branched  $\text{C}_2$  to  $\text{C}_{10}$  alkenyl group, a linear or branched  $\text{C}_2$  to  $\text{C}_{10}$  alkynyl group, a  $\text{C}_3$  to  $\text{C}_{10}$  cyclic alkyl group, a  $\text{C}_3$  to  $\text{C}_{10}$  hetero-cyclic alkyl group, a  $\text{C}_5$  to  $\text{C}_{10}$  aryl group, and a  $\text{C}_3$  to  $\text{C}_{10}$  hetero-aryl group; and  $\text{R}^4$  is a  $\text{C}_3$  to  $\text{C}_{10}$  alkyl di-radical which forms a four-membered, five-membered, or six-membered saturated cyclic ring with the  $\text{Si}$  atom, optionally at least one oxygen source, and optionally at least one porogen;
- applying energy to the gaseous reagents in the reaction chamber to induce reaction of the gaseous reagents to deposit a preliminary film on the substrate, wherein the preliminary film contains the porogen; and
- removing from the preliminary film at least a portion of the porogen to provide the porous dielectric film comprising pores and a dielectric constant of about 2.6 or less.

2. The method of claim 1 wherein the structure-forming precursor further comprises a hardening additive.

3. The method of claim 1 wherein the alkoxysilacyclic or acyloxysilacyclic compound comprises at least one selected from the group consisting of 1,1-dimethoxy-1-silacyclopentane, 1,1-diethoxy-1-silacyclopentane, 1,1-di-n-propoxy-1-silacyclopentane, 1,1-di-iso-propoxy-1-silacyclopentane, 1,1-dimethoxy-1-silacyclobutane, 1,1-diethoxy-1-silacyclobutane, 1,1-di-n-propoxy-1-silacyclobutane, 1,1-di-iso-propoxy-1-silacyclobutane, 1,1-dimethoxy-1-silacyclohexane, 1,1-di-iso-propoxy-1-silacyclohexane, 1,1-di-n-propoxy-1-silacyclohexane, 1-methoxy-1-acetoxy-1-silacyclopentane, 1,1-diacetoxy-1-silacyclopentane, 1-methoxy-1-acetoxy-1-silacyclobutane, 1,1-diacetoxy-1-silacyclobutane, 1-methoxy-1-acetoxy-1-silacyclohexane, 1,1-diacetoxy-1-silacyclohexane, 1-ethoxy-1-acetoxy-1-silacyclopentane, 1-ethoxy-1-acetoxy-1-silacyclobutane, and combinations thereof.
4. The method of claim 1 wherein the porogen is cyclooctane.
5. The method of claim 2 wherein the hardening additive comprises tetraethoxysilane.
6. The method of claim 2 wherein the hardening additive comprises tetramethoxysilane.
7. The method of claim 1 which is a plasma enhanced chemical vapor deposition method.
8. The method of claim 1 where the reaction mixture comprises the at least one oxidant selected from the group consisting of O<sub>2</sub>, N<sub>2</sub>O, NO, NO<sub>2</sub>, CO<sub>2</sub>, water, H<sub>2</sub>O<sub>2</sub>, ozone, and combinations thereof.
9. The method of claim 1 where the reaction mixture does not comprise an oxidant.
10. The method of claim 1 where the reaction chamber in the applying step comprises at least one gas selected from the group consisting of He, Ar, N<sub>2</sub>, Kr, Xe, NH<sub>3</sub>, H<sub>2</sub>, CO<sub>2</sub>, and CO.
11. The method of claim 1 wherein the removing step comprises at least one treatment selected from the group consisting of thermal treatment, an ultraviolet (UV) treatment, an electron beam treatment, a gamma radiation treatment, and a combination thereof.

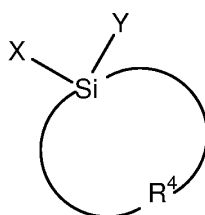
12. The method of claim 11 wherein the UV treatment occurs during at least a portion of the thermal treatment.

13. The method of claim 1 wherein the porogen precursor is selected from the group consisting of:

- a.) a substituted or unsubstituted cyclic hydrocarbon having the formula  $C_nH_{2n}$  wherein  $n = 4$  to  $14$ ,
- b.) a substituted or unsubstituted hydrocarbon of the general formula  $C_nH_{(2n+2)-2y}$  wherein  $n = 2$  to  $20$  and  $y = 0$  to  $n$ , wherein  $n = 4$  to  $14$ ,
- c.) a substituted or unsubstituted singly or multiply unsaturated cyclic hydrocarbon having the formula  $C_nH_{2n-2x}$  wherein  $x$  is the number of unsaturated sites in the molecule and  $n = 4$  to  $14$ ,
- d.) a substituted or unsubstituted bicyclic hydrocarbon having the formula  $C_nH_{2n-2}$  wherein  $n = 4$  to  $14$ ,
- e.) a substituted or unsubstituted multiply unsaturated bicyclic hydrocarbon having the formula  $C_nH_{2n-(2+2x)}$ , where  $x$  is the number of unsaturated sites in the molecule, and  $n = 4$  to  $14$ , wherein the number of carbons in the bicyclic structure is between  $4$  and  $12$ , and
- f.) a substituted or unsubstituted tricyclic hydrocarbon having the formula  $C_nH_{2n-4}$  where  $n = 4$  to  $14$ , where the number of carbons in the tricyclic structure is between  $4$  and  $12$ .

14. The method of claim 1 wherein the porogen precursor in claim 13 comprises at least one selected from the group consisting of cyclohexane, 1,2,4-trimethylcyclohexane, 1-methyl-4-(1-methylethyl)cyclohexane, cyclooctane, methylcyclooctane, ethylene, propylene, acetylene, neohexane, 1,3-butadiene, 2-methyl-1,3-butadiene, 2,3-dimethyl-2,3-butadiene, substituted dienes, para-cymene, cyclooctene, 1,5-cyclooctadiene, cyclohexene, vinyl-cyclohexane, dimethylcyclohexene, alpha-terpinene, pinene, limonene, vinyl-cyclohexene, norbornane, spiro-nonane, camphene, norbornene, norbornadiene, 5-ethylidene-2-norbornene, decahydronaphthalene, adamantane, and combinations thereof.

15. A composition for chemical vapor deposition of a dielectric film, wherein the composition comprises an alkoxysilacyclic or an acyloxysilacyclic compound having the following Formula I:



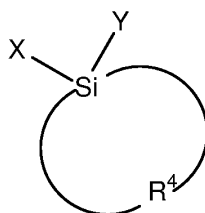
(I),

- wherein X and Y are independently selected from the group consisting of  $OR^1$ ,  $OR^2$ , and  $OC(O)R^3$ , wherein  $R^{1-3}$  are each independently selected from the group consisting of a linear or branched  $C_1$  to  $C_{10}$  alkyl group, a linear or branched  $C_2$  to  $C_{10}$  alkenyl group, a linear or branched  $C_2$  to  $C_{10}$  alkynyl group, a  $C_3$  to  $C_{10}$  cyclic alkyl group, a  $C_3$  to  $C_{10}$  hetero-cyclic alkyl group, a  $C_5$  to  $C_{10}$  aryl group, and a  $C_3$  to  $C_{10}$  hetero-aryl group; and  $R^4$  is a  $C_3$  to  $C_{10}$  alkyl di-radical which forms either a four-membered, five-membered, or six-membered saturated cyclic ring with the Si atom, and wherein the compound is substantially free of one or more impurities selected from the group consisting of a halide, water, and combinations thereof.

16. The composition of claim 15 wherein the alkoxy-silacyclic or acyloxy-silacyclic compound comprises at least one selected from the group consisting of 1,1-dimethoxy-1-silacyclopentane, 1,1-diethoxy-1-silacyclopentane, 1,1-di-n-propoxy-1-silacyclopentane, 1,1-di-iso-propoxy-1-silacyclopentane, 1,1-dimethoxy-1-silacyclobutane, 1,1-diethoxy-1-silacyclobutane, 1,1-di-n-propoxy-1-silacyclobutane, 1,1-di-iso-propoxy-1-silacyclobutane, 1,1-dimethoxy-1-silacyclohexane, 1,1-di-iso-propoxy-1-silacyclohexane, 1,1-di-n-propoxy-1-silacyclohexane, 1-methoxy-1-acetoxy-1-silacyclopentane, 1,1-diacetoxy-1-silacyclopentane, 1-methoxy-1-acetoxy-1-silacyclobutane, 1,1-diacetoxy-1-silacyclobutane, 1-methoxy-1-acetoxy-1-silacyclohexane, 1,1-diacetoxy-1-silacyclohexane, 1-ethoxy-1-acetoxy-1-silacyclopentane, 1-ethoxy-1-acetoxy-1-silacyclobutane, and combinations thereof.

17. The composition of claim 15, wherein the halide comprises chloride ions.

18. The use of an alkoxy-silacyclic or acyloxy-silacyclic compound for depositing a low k dielectric film via vapor deposition having the following Formula I:



(I)

wherein X and Y are independently selected from the group consisting of OR<sup>1</sup>, OR<sup>2</sup>, and OC(O)R<sup>3</sup>, wherein R<sup>1-3</sup> are each independently selected from the group consisting of a  
 5 linear or branched C<sub>1</sub> to C<sub>10</sub> alkyl group, a linear or branched C<sub>2</sub> to C<sub>10</sub> alkenyl group, a linear or branched C<sub>2</sub> to C<sub>10</sub> alkynyl group, a C<sub>3</sub> to C<sub>10</sub> cyclic alkyl group, a C<sub>3</sub> to C<sub>10</sub> hetero-cyclic alkyl group, a C<sub>5</sub> to C<sub>10</sub> aryl group, and a C<sub>3</sub> to C<sub>10</sub> hetero-aryl group; and R<sup>4</sup> is a C<sub>3</sub> to C<sub>10</sub> alkyl di-radical which forms a four-membered, five-membered, or six-membered saturated cyclic ring with the Si atom.

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19. The use of claim 18, wherein the compound is substantially free of one or more impurities selected from the group consisting of a halide, water, and combinations thereof.

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20. The use of claim 18, wherein the alkoxy-silacyclic or acyloxy-silacyclic compound comprises at least one selected from the group consisting of 1,1-dimethoxy-1-silacyclopentane, 1,1-diethoxy-1-silacyclopentane, 1,1-di-n-propoxy-1-silacyclopentane, 1,1-di-iso-propoxy-1-silacyclopentane, 1,1-dimethoxy-1-silacyclobutane, 1,1-diethoxy-1-silacyclobutane, 1,1-di-n-propoxy-1-silacyclobutane, 1,1-di-iso-propoxy-1-silacyclobutane,  
 20 1,1-dimethoxy-1-silacyclohexane, 1,1-di-iso-propoxy-1-silacyclohexane, 1,1-di-n-propoxy-1-silacyclohexane, 1-methoxy-1-acetoxy-1-silacyclopentane, 1,1-diacetoxy-1-silacyclopentane, 1-methoxy-1-acetoxy-1-silacyclobutane, 1,1-diacetoxy-1-silacyclobutane, 1-methoxy-1-acetoxy-1-silacyclohexane, 1,1-diacetoxy-1-silacyclohexane, 1-ethoxy-1-acetoxy-1-silacyclopentane, 1-ethoxy-1-acetoxy-1-silacyclobutane, and combinations thereof.

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21. The use of claim 19, wherein the halide comprises chloride ions.

22. The use of claim 21, wherein the chloride ions are less than 50 ppm.

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23. The use of claim 21, wherein the chloride ions are less than 10 ppm.

24. The use of claim 21, wherein the chloride ions are less than 5 ppm.

25. The use of claim 18, which the vapor deposition is a chemical vapor  
5 deposition.

26. The use of claim 25, wherein the chemical vapor deposition is a plasma  
enhanced chemical vapor deposition.

10 27. The composition of claim 15 further comprising at least one member selected  
from the group consisting of carrier gases and oxidants.

28. The composition of claim 27 wherein the member comprises at least one  
member selected from the group consisting of helium and oxygen.  
15

29. The composition of claim 15 further comprising at least one hardening additive.

30. The composition of claim 29 wherein the hardening additive comprises at least  
one tetraalkoxysilane.  
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31. A film formed by the method wherein the film structure comprises at least one of  
-CH<sub>2</sub>- methylene and -CH<sub>2</sub>CH<sub>2</sub>- ethylene bridges.  
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