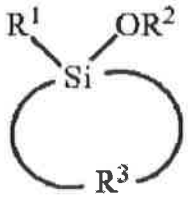
CLAIMS

1. A dielectric film deposition composition comprising at least one alkyl-alkoxysilacyclic compound having the following Formula I:

(I)



wherein R^1 is independently selected from hydrogen, 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; R^2 is selected from hydrogen, 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^3 is selected from a C_3 to C_{10} saturated alkyl di-radical which forms a four-membered, five-membered, or six-membered cyclic ring with the Si atom, wherein the compound contains less than about 100 ppm of impurities, and wherein the composition can be reacted as a gaseous reagent to deposit the film upon a substrate.

2. The composition of claim 1 wherein the film is deposited by a 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 alkyl-alkoxysilacyclic compound, and a 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.

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

4. The composition of claim 3 wherein the hardening additive comprises tetraethoxysilane.

5. The composition of claim 2 wherein the porogen is cyclooctane.

6. The composition of claim 2 where the chemical vapor deposition method is plasma enhanced chemical vapor deposition.

7. The composition of claim 2 where the reaction mixture comprises the at least one oxidant selected from the group consisting of O_2, N_2O, NO, NO_2, CO_2, water, H_2O_2, ozone, and combinations thereof.

8. The composition of claim 2 where the reaction mixture does not comprise an oxidant.

9. The composition of claim 8 wherein the UV treatment occurs during at least a portion of the thermal treatment.

10. The composition of claim 2 where the reaction chamber in the applying step comprises at least one gas selected from He, Ar, N_2, Kr, Xe, NH_3, H_2, CO_2, or CO.

11. The composition of claim 2 wherein the removing step comprises a thermal treatment, an ultraviolet treatment, an electron beam treatment, a gamma radiation treatment, and a combination thereof.

12. The composition of claim 2 wherein the porogen precursor is selected from the group of:

a.) a cyclic hydrocarbon having the formula C_nH_{2n} wherein n=4-14 and wherein the cyclic hydrocarbon is unsubstituted or substituted with a plurality of a linear or a branched hydrocarbon;

b.) a linear or branched, saturated, singly or multiply unsaturated hydrocarbons of the general formula $C_nH_{(2n+2)-2y}$ wherein n=2-20 and wherein y=0-n;

c.) a singly or multiply unsaturated cyclic hydrocarbons having the formula C_nH_{2n-2x} wherein x is the number of unsaturated sites in the molecule and n=4-14, and wherein the cyclic hydrogen is unsubstituted or substituted with a plurality of a linear or a branched hydrocarbon; and wherein if the cyclic hydrocarbon is unsaturated the unsaturation is located within endocyclic or on one of the hydrocarbon substituents to the cyclic structure;

d.) a bicyclic hydrocarbon having the formula C_nH_{2n-2} wherein n=4-14 and wherein the cyclic hydrocarbon is unsubstituted or substituted with a plurality of a linear or a branched hydrocarbon;

e.) a multiply unsaturated bicyclic hydrocarbons having the formula $C_nH_{2n-(2+2x)}$ where x is the number of unsaturated sites in the molecule, n=4-14, wherein the number of carbons in the bicyclic structure is between 4 and 12, wherein the cyclic hydrocarbon is unsubstituted or substituted with a plurality of a linear or a branched hydrocarbon; and wherein if the hydrocarbon was unsaturated, the unsaturation is located on endocyclic or on one of the hydrocarbon substituents to the cyclic structure; and

f.) a tricyclic hydrocarbons having the formula C_nH_{2n-4} where n=4-14, where the number of carbons in the tricyclic structure is between 4 and 12, and wherein the cyclic hydrocarbon is unsubstituted or substituted with a plurality of a linear or a branched hydrocarbon.

13. The composition of claim 2 wherein the porogen precursor in claim 12 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, adamantine, and combinations thereof.

14. The composition of claim 1 wherein the alkyl-alkoxysilacyclic compound comprises at least one selected from the group consisting of 1-methyl-1-methoxy-1-silacyclopentane, 1-methyl-1-ethoxy-1-silacyclopentane, 1-methyl-1-isopropoxy-1-silacyclopentane, 1-methyl-1-propoxy-1-silacyclopentane, 1-methoxy-1-silacyclopentane, 1-ethoxy-1-silacyclopentane, 1-methyl-1-methoxy-1-silacyclobutane, 1-methyl-1-ethoxy-1-silacyclobutane, 1-methoxy-1-silacyclobutane, 1-ethoxy-1-silacyclobutane, 1-methyl-1-methoxy-1-silacyclohexane, 1-methyl-1-ethoxy-1-silacyclohexane, 1-methyl-1-methoxy-1-silacyclohexane, 1-methyl-1-ethoxy-1-silacyclohexane, 1-methyl-1-isopropoxy-1-silacyclopentane, 1-methyl-1-isopropoxy-1-silacyclobutane, 1-methyl-1-isopropoxy-1-silacyclohexane, 1-isopropoxy-1-silacyclopentane, 1-isopropoxy-1-silacyclobutane, 1-isopropoxy-1-silacyclohexane and combinations thereof.

15. The composition of claim 14, wherein the impurities comprise chloride ions.

16. The composition of claim 14 wherein the alky-alkoxysilacyclic compound comprises 1-methyl-1-ethoxy-1-silacyclopentane.

17. The composition of claim 1 further comprising at least one porogen precursor.

18. The composition of claim 1 further comprising at least one oxidant.

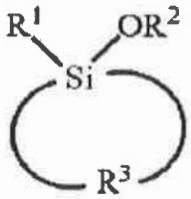
19. The composition of claim **1** further comprising at least one inert gas.

20. The composition of claim **1** wherein the film comprises an organosilicate glass.

21. The composition of claim **1** wherein the film has a dielectric constant of about 2.7 or less.

22. A film deposition composition consisting essentially of at least one alkyl-alkoxysilacyclic compound having the following Formula I:

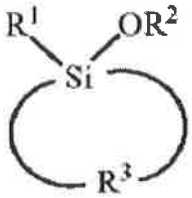
(I)



wherein R^1 is independently selected from hydrogen, 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; R^2 is selected from hydrogen, 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^3 is selected from a C_3 to C_{10} saturated alkyl di-radical which forms a four-membered, five-membered, or six-membered cyclic ring with the Si atom.

23. The composition of claim **22** wherein the alkyl-alkoxysilacyclic compound comprises a compound having the following Formula I:

(I)



wherein R^1 is independently selected from hydrogen, 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; R^2 is selected from hydrogen, 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^3 is selected from a C_3 to C_{10} saturated alkyl di-radical which forms a four-membered, five-membered, or six-membered cyclic ring with the Si atom, and at least one porogen.

24. The composition of claim **23** wherein the alkyl-alkoxysilacyclic compound comprises at least one selected from the group consisting of 1-methyl-1-methoxy-1-silacyclopentane, 1-methyl-1-ethoxy-1-silacyclopentane, 1-methyl-1-isopropoxy-1-silacyclopentane, 1-methyl-1-propoxy-1-silacyclopentane, 1-methoxy-1-silacyclopentane, 1-ethoxy-1-silacyclopentane, 1-methyl-1-methoxy-1-silacyclobutane, 1-methyl-1-ethoxy-1-silacyclobutane, 1-methoxy-1-silacyclobutane, 1-ethoxy-1-silacyclobutane, 1-methyl-1-methoxy-1-silacyclohexane, 1-methyl-1-ethoxy-1-silacyclohexane, 1-methyl-1-methoxy-1-silacyclohexane, 1-methyl-1-ethoxy-1-silacyclohexane, 1-methyl-1-isopropoxy-1-silacyclopentane, 1-methyl-1-isopropoxy-1-silacyclobutane, 1-methyl-1-isopropoxy-1-silacyclohexane, 1-isopropoxy-1-silacyclopentane, 1-isopropoxy-1-silacyclobutane, 1-isopropoxy-1-silacyclohexane and combinations thereof.

25. The composition of claim **24** wherein the alkyl-alkoxysilacyclic compound comprises 1-methyl-1-ethoxy-1-silacyclopentane.

26. The composition of claim **24** wherein the alkyl-alkoxysilacyclic compound comprises 1-methyl-1-iso-propoxy-1-silacyclopentane.

27. The composition of claim **24** wherein the alkyl-alkoxysilacyclic compound comprises 1-methyl-1-propoxy-1-silacyclopentane.

28. The composition of claim **27** wherein the hardening additive comprises tetramethoxysilane.

29. A dielectric film deposition composition comprising at least one member selected from the group consisting of 1-methyl-1-ethoxy-1-silacyclopentane, 1-methyl-1-iso-propoxy-1-silacyclopentane, and 1-methyl-1-propoxy-1-si-lacyclopentane.

30. The composition of claim **29** further comprising at least one porogen.

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