CLAIMS

1. A method for making an organosilica film with improved mechanical properties, the method comprising the steps of:

providing a substrate within a reaction chamber; introducing into the reaction chamber a gaseous composition comprising at least one mono- or dialkoxysilane having the structure given in Formula (1) or (2):

(1) $HR^1R^2SiOR^3$

wherein R^1 is methyl, R^2 is selected from a branched or cyclic C_3 to C_{10} alkyl, preferably iso-propyl or tert-butyl, and R^3 is selected from a linear, branched or cyclic C_1 to C_{10} alkyl, preferably methyl, ethyl, propyl, iso-propyl, butyl, sec-butyl, iso-butyl, tert-butyl, or cyclohexyl;

(2) $R^4R^5Si(OR^6)_2$

wherein R^4 is hydrogen or methyl, R^5 is selected from a linear, branched or cyclic C_1 to C_{10} alkyl, preferably iso-propyl or tert-butyl, and R^6 is selected from a linear, branched, or cyclic C_3 to C_{10} alkyl, preferably iso-propyl, sec-butyl, iso-butyl, cyclohexyl or tert-butyl; and

applying energy to the gaseous composition comprising mono- or dialkoxysilane in the reaction chamber to induce reaction of the gaseous composition comprising mono- or dialkoxysilane to deposit an organosilica film on the substrate, wherein the organosilica film has a dielectric constant of from 2.80 to 3.30 and an elastic modulus of from t 7 to 30 GPa,

wherein the gaseous composition is substantially free of halides.

2. The method of claim 1 wherein the gaseous composition comprising at least one mono- or dialkoxysilane is free of a hardening additive.

3. The method of claim 1 wherein the mono- or dialkoxysilane of Formula (1) or (2) is substantially free of one or more impurities selected from the group consisting of a halide, water, metals, and combinations thereof.

4. The method of claim 1 which is a chemical vapor deposition method.

5. The method of claim 1 which is a plasma enhanced chemical vapor deposition method.

6. The method of claim 1 wherein the gaseous composition comprising at least one mono- or dialkoxysilane comprises 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.

7. The method of claim 1 wherein the gaseous composition comprising at least one mono- or dialkoxysilane does not comprise an oxidant.

8. The method of claim 1 wherein in the applying step the reaction chamber contains at least one gas selected from the group consisting of He, Ar, N_2, Kr, Xe, CO_2, and CO.

9. The method of claim 1 wherein the organosilica film has a refractive index (RI) of from about 1.3 to about 1.6 at 632 nm and an at. % carbon as measured by XPS of from 10 % to 30%.

10. The method of claim 1 wherein the organosilica film is deposited at a rate of from 5 nm/min to 700 nm/min.

11. The method of claim 8 wherein the organosilica film has a $SiCH_2Si/SiO_x$*1E4 IR ratio of from 10 to 30.

12. The method of claim 1 wherein the mono- or di-alkoxysilane in the gaseous composition comprises one or more precursors selected from the group consisting of iso-propyl-methyl-methoxysilane, isopropyl-methyl-ethoxysilane, n-butyl-methyl-iso-propoxysilane, iso-butyl-methyl-iso-propoxysilane, isopropyl-methyl-isopropoxysilane, sec-butylmethylmethoxysilane, sec-butylmethylethoxysilane, sec-butylmethyl-iso-propoxysilane, t-butyl-methyl-methoxysilane, t-butyl-methyl-ethoxysilane, t-butyl-methyl-isopropoxysilane, cyclohexyl-methyl-methoxysilane, cyclopentyl-methyl-methoxysilane, cyclopentyl-methyl-iso-propoxysilane, cyclohexyl-methyl-ethoxy silane, cyclohexyl-iso-propoxymethylsilane, di-iso-propoxy-dimethylsilane, di-isopropoxy-methylsilane, di-t-butoxy-dimethylsilane, di-t-butoxy-methylsilane, dicyclohexoxy-dimethylsilane, dicyclohexoxy-methylsilane, di-sec-butoxy-dimethylsilane, di-sec-butoxy-methylsilane, dicyclopentoxydimethylsilane, and dicyclopentoxymethylsilane.

13. The method of claim 1 wherein the mono- or dialkoxysilane in the gaseous composition comprises one or more precursors selected from the group consisting of iso-

propyl-methyl-ethoxysilane, iso-methyl-propyl-iso-propoxysilane, di-iso-propoxy-dimethylsilane, di-t-butoxy-dimethylsilane, di-sec-butoxy-dimethylsilane, dicyclohexoxy-dimethylsilane, dicyclohexoxymethylsilane, dicyclopentoxy-dimethylsilane, and dicyclopentoxymethylsilane.

14. A gaseous composition comprising at least one mono- or dialkoxysilane having the structure given in Formula (1) or (2):

(1) $HR^1R^2SiOR^3$

wherein R^1 is methyl, R^2 is selected from a branched or cyclic C_3 to C_{10} alkyl, preferably iso-propyl or tert-butyl, and R^3 is selected from a linear, branched or cyclic C_1 to C_{10} alkyl, preferably methyl, ethyl, propyl, iso-propyl, butyl, sec-butyl, iso-butyl, tert-butyl, or cyclohexyl;

(2) $R^4R^5Si(OR^6)_2$

wherein R^4 is hydrogen or methyl, R^5 is selected from a linear, branched or cyclic C_1 to C_{10} alkyl, preferably iso-propyl or tert-butyl, and R^6 is selected from a linear, branched, or cyclic C_3 to C_{10} alkyl, preferably iso-propyl, sec-butyl, iso-butyl, cyclohexyl or tert-butyl,

wherein the gaseous composition is substantially free of a halide.

15. The gaseous composition of claim 14 wherein the at least one mono-or dialkoxysilane is selected from the group consisting of iso-propyl-methyl-methoxysilane, isopropyl-methyl-ethoxysilane, n-butyl-methyl-iso-propoxysilane, iso-butyl-methyl-iso-propoxysilane, isopropyl-methyl-isopropoxysilane, sec-butylmethylmethoxysilane, sec-butylmethylethoxysilane, sec-butylmethyl-iso-propoxysilane, t-butyl-methyl-methoxysilane, t-butyl-methyl-ethoxysilane, t-butyl-methyl-isopropoxysilane, cyclohexyl-methyl-methoxysilane, cyclopentyl-methyl-methoxysilane, cyclopentyl-methyl-iso-propoxysilane, cyclohexyl-methyl-ethoxy silane, cyclohexyl-iso-propoxymethylsilane, di-iso-propoxy-dimethylsilane, di-isopropoxy-methylsilane, di-t-butoxy-dimethylsilane, di-t-butoxy-methylsilane, dicyclohexoxy-dimethylsilane, dicyclohexoxy-methylsilane, di-sec-butoxy-dimethylsilane, di-sec-butoxy-methylsilane, dicyclopentoxydimethylsilane, and dicyclopentoxymethylsilane.

16. The gaseous composition of claim 14 wherein the at least one mono- or dialkoxysilane is selected from the group consisting of iso-propyl-methyl-ethoxysilane, iso-methyl-propyl-iso-propoxysilane, di-iso-propoxy-dimethylsilane, di-t-butoxy-dimethylsilane,

di-sec-butoxy-dimethylsilane, dicyclohexoxy-dimethylsilane, dicyclohexoxymethylsilane, dicyclopentoxy-dimethylsilane, and dicyclopentoxymethylsilane.

17. The gaseous composition of claim 14 having less than 5 ppm of metals selected from the group consisting of Li, Na, K, Mg, Ca, Al, Fe, Fe, Ni, and Cr as measured by ICP-MS.

18. The gaseous composition of claim 14 having less than 0.1 ppm of the metals selected from the group consisting of Li, Na, K, Mg, Ca, Al, Fe, Fe, Ni, and Cr as measured by ICP-MS.

19. The composition of claim 14, wherein the halide is chloride ions, if present, are present at a concentration of 10 ppm or less as measured by IC.

20. The composition of claim 14, wherein the halide is chloride ions, if present, are present at a concentration of 5 ppm or less as measured by IC

21. A gaseous composition for vapor deposition of silicon-containing films comprising at least one mono- or dialkoxysilane selected from the group consisting of iso-butyl-methyl-iso-propoxysilane, isopropyl-methyl-isopropoxysilane, sec-butylmethylethoxysilane, sec-butylmethyl-iso-propoxysilane, t-butyl-methyl-isopropoxysilane, cyclohexylethoxymethylsilane, cyclohexylisopropoxymethylsilane, di-iso-propoxy-dimethylsilane, di-t-butoxy-dimethylsilane, di-sec-butoxy-dimethylsilane, dicyclohexoxy-dimethylsilane, dicyclohexoxymethylsilane, dicyclopentoxy-dimethylsilane, and dicyclopentoxymethylsilane, wherein the gaseous composition is substantially free of halides.