CLAIMS

1). A composition comprising:

(a) at least one silicon precursor compound having one Si-C-Si or two Si-C-Si linkages selected from the group consisting of 1,1,1,3,3,3-hexachloro-1,3-disilapropane, 1,1,1,3,3,3-hexachloro-2-methyl-1,3-disilapropane, 1,1,1,3,3,3-hexachloro-2,2-dimethyl-1,3-disilapropane, 1,1,1,3,3,3-hexachloro-2-ethyl-1,3-disilapropane, 1-chloro-1,3-disilacyclobutane, 1-bromo-1,3-disilacyclobutane, 1,3-dichloro-1,3-1,3-disilacyclobutane, 1,3-dibromo-1,3-disilacyclobutane, 1,1,3-trichloro-1,3-disilacyclobutane, 1,1,3-tribromo-1,3-disilacyclobutane, , 1,1,3,3-tetrabromo-1,3-disilacyclobutane, 1,3-dichloro-1,3-dimethyl-1,3-disilacyclobutane, 1,3-bromo-1,3-dimethyl-1,3-disilacyclobutane, 1,1,1,3,3,5,5,5-octachloro-1,3,5-trisilapentane, 1,1,1,3,3,5,5,5-octachloro-1,3,5-trisilapentane, 1,1,1,3,3,5,5,5-octachloro-1,5-dimethyl-1,3,5-trisilapentane, 1,1,1,5,5,5-hexachloro-3,3-dimethyl-1,3,5-trisilapentane, 1,1,3,5,5,5-pentachloro-1,3,5-trimethyl-1,3,5-trisilapentane, 1,1,1,5,5,5-hexachloro-1,3,5-trisilapentane, 1,1,5,5-tetraachloro-1,3,5-trisilapentane; and;

(b) at least one solvent.

2). The composition of claim 1 where in the solvent comprises at least one member selected from the group consisting of ether, tertiary amine, siloxanes, alkyl hydrocarbon, aromatic hydrocarbon, and tertiary aminoether.

3). The composition of claim 1 wherein the difference between the boiling point of the silicon precursor and the boiling point of the solvent is about 40°C or less.

4). The composition of claim 1 comprising less than 5ppm of at least one metal ions selected from the group consisting of Al^{3+} ions, Fe^{2+}, Fe^{3+}, Ni^{2+}, and Cr^{3+}.

5). The composition of claim 1 where in the solvent comprises at least one member selected from the group consisting of heptane, octane, nonane, decane, dodecane, cyclooctane, cyclononane, cyclodecane, toluene, and mesitylene.

6). A method for forming a carbon doped silicon oxide film having carbon content ranging from 15 at. % to 30 at.% via a thermal ALD process, the method comprising:

a) placing one or more substrates comprising a surface feature into a reactor;

b) heating to reactor to one or more temperatures ranging from ambient temperature to about 550°C and optionally maintaining the reactor at a pressure of 100 torr or less;

c) introducing into the reactor at least one silicon precursor having two Si-C-Si linkages selected from the group consisting of 1-chloro-1,3-disilacyclobutane, 1-bromo-1,3-disilacyclobutane, 1,3-dichloro-1,3-1,3-disilacyclobutane, 1,3-dibromo-1,3-disilacyclobutane, 1,1,3-trichloro-1,3-disilacyclobutane, 1,1,3-tribromo-1,3-disilacyclobutane, 1,1,3,3-tetrachloro-1,3-disilacyclobutane, 1,1,3,3-tetrabromo-1,3-disilacyclobutane, 1,3-dichloro-1,3-dimethyl-1,3-disilacyclobutane, 1,3-bromo-1,3-dimethyl-1,3-disilacyclobutane, 1,1,1,3,3,5,5,5-octachloro-1,3,5-trisilapentane, 1,1,1,3,3,5,5,5-octachloro-1,3,5-trisilapentane, 1,1,1,3,3,5,5,5-octachloro-1,5-dimethyl-1,3,5-trisilapentane, 1,1,1,5,5,5-hexachloro-3,3-dimethyl-1,3,5-trisilapentane, 1,1,3,5,5,5-pentachloro-1,3,5-trimethyl-1,3,5-trisilapentane, 1,1,1,5,5,5-hexachloro-1,3,5-trisilapentane, 1,1,5,5-tetraachloro-1,3,5-trisilapentane;

d) purge with an inert gas;

e) providing a nitrogen source into the reactor to react with the surface to form a carbon doped silicon nitride film;

f) purge with inert gas to remove reaction by-products;

g) steps c to f are repeated to provide a desired thickness of carbon doped silicon nitride;

h) treating the resulting carbon doped silicon nitride film with an oxygen source at one or more temperatures ranging from about ambient temperature to 1000oC or from about 100o to 400oC to convert the carbon doped silicon nitride film into a carbon doped silicon oxide film; and

~~i) providing post-deposition exposing the carbon doped silicon oxide film to a plasma comprising hydrogen.~~

~~7) The method of Claim 6 wherein the silicon precursor comprises the composition of Claim 1.~~

~~8) A film formed according to the method of claim 6 having a k of less than about 4, a carbon content of at least about 10 at. %.~~

~~9) A film formed according to the method of claim 6 having an etch rate of at least 0.5 times less than thermal silicon oxide.~~

~~10) A film formed according to the method of claim 6 having an etch rate of at least 0.1 times less than thermal silicon oxide.~~

~~11) A film formed according to the method of claim 6 having an etch rate of at least 0.05 times less than thermal silicon oxide.~~

~~12) A film formed according to the method of claim 6 having an etch rate of at least 0.01 times less than thermal silicon oxide.~~

~~13) A film formed according to the method of claim 6 having less damage layer (50 Å or less) when exposing to oxygen ashing process.~~

~~14) A film formed according to the method of claim 6 having less damage layer (20 Å or less) when exposing to oxygen ashing process.~~

~~15) A film formed according to the method of claim 6 having less damage layer (10 Å or less) when exposing to oxygen ashing process.~~

~~16) A film formed according to the method of claim 6 having less damage layer (5 Å or less) when exposing to oxygen ashing process.~~

~~17) A stainless steel container housing the composition of claim 1.~~

~~18) A method for forming a carbon doped silicon oxide film having carbon content ranging from 15 at % to 30 at.% via a thermal ALD process, the method comprising the method comprising:~~

~~a. placing one or more substrates comprising a surface feature into a reactor;~~

~~b. heating the reactor to one or more temperatures ranging from ambient temperature to about 150°C and optionally maintaining the reactor at a pressure of 100 torr or less;~~

~~c. introducing into the reactor at least precursor having two Si-C-Si linkages selected from the group consisting of 1-chloro-1,3-disilacyclobutane, 1-bromo-1,3-disilacyclobutane, 1,3-dichloro-1,3-1,3-disilacyclobutane, 1,3-dibromo-1,3-disilacyclobutane, 1,1,3-trichloro-1,3-disilacyclobutane, 1,1,3-tribromo-1,3-disilacyclobutane, 1,1,3,3-tetrachloro-1,3-disilacyclobutane, 1,1,3,3-tetrabromo-1,3-disilacyclobutane, 1,3-dichloro-1,3-dimethyl-1,3-disilacyclobutane, 1,3-bromo-1,3-dimethyl-1,3-disilacyclobutane, 1,1,1,3,3,5,5,5-octachloro-1,3,5-trisilapentane, 1,1,1,3,3,5,5,5-octachloro-1,3,5-trisilapentane, 1,1,1,3,3,5,5,5-octachloro-1,5-dimethyl-1,3,5-trisilapentane, 1,1,1,5,5,5-hexachloro-3,3-dimethyl-1,3,5-trisilapentane, 1,1,3,5,5,5-pentachloro-1,3,5-trimethyl-1,3,5-trisilapentane, 1,1,1,5,5,5-hexachloro-1,3,5-trisilapentane, 1,1,5,5-tetraachloro-1,3,5-trisilapentane and a catalyst;~~

~~d. purge with an inert gas~~

e. providing vapors of water into the reactor to react with the precursor as well as a catalyst to form a carbon doped silicon oxide as-deposited film;

f. purge with inert gas to remove reaction by-products;

g. steps c to f are repeated to provide a desired thickness of carbon doped silicon oxide;

19. The method of Claim 18 further comprising post-deposition treatment of the carbon doped silicon oxide film with a thermal anneal at temperatures from 300 to 700°C.

20. The method of Claim 18 further comprising hydrogen plasma treatment of the carbon doped silicon oxide film with a plasma comprising hydrogen.

CLAIMS

1. A method for forming a carbon doped silicon oxide film having carbon content ranging from 15 at. % to 30 at. % via a thermal ALD process, the method comprising:

a) placing one or more substrates comprising a surface feature into a reactor;

b) heating the reactor to one or more temperatures ranging from ambient temperature to about 550° C. and optionally maintaining the reactor at a pressure of 100 torr or less;

c) introducing into the reactor at least one silicon precursor having two Si—C—Si linkages selected from the group consisting of 1-chloro-1,3-disilacyclobutane, 1-bromo-1,3-disilacyclobutane, 1,3-dichloro-1,3-1,3-disilacyclobutane, 1,3-dibromo-1,3-disilacyclobutane, 1,1,3-trichloro-1,3-disilacyclobutane, 1,1,3-tribromo-1,3-disilacyclobutane, 1,1,3,3-tetrachloro-1,3-disilacyclobutane, 1,1,3,3-tetrabromo-1,3-disilacyclobutane, 1,3-dichloro-1,3-dimethyl-1,3-disilacyclobutane, 1,3-bromo-1,3-dimethyl-1,3-disilacyclobutane, 1,1,1,3,3,5,5,5-octachloro-1,3,5-trisilapentane, 1,1,3,3,5,5-hexachloro-1,5-dimethyl-1,3,5-trisilapentane, 1,1,1,5,5,5-hexachloro-3,3-dimethyl-1,3,5-trisilapentane, 1,1,3,5,5-pentachloro-1,3,5-trimethyl-1,3,5-trisilapentane, 1,1,1,5,5,5-hexachloro-1,3,5-trisilapentane, 1,1,5,5-tetraachloro-1,3,5-trisilapentane;

d) purging with an inert gas;

e) providing a nitrogen source into the reactor to react with the surface to form a carbon doped silicon nitride film;

f) purging with inert gas to remove reaction by-products;

g) repeating steps c to f to provide a desired thickness of a resulting carbon doped silicon nitride;

h) treating the resulting carbon doped silicon nitride film with an oxygen source at one or more temperatures ranging from about ambient temperature to 1000° C. to convert the carbon doped silicon nitride film into a carbon doped silicon oxide film; and

i) providing post-deposition exposing the carbon doped silicon oxide film to a plasma comprising hydrogen.

2. The method according to claim 1 wherein the step h) of treating the resulting carbon doped silicon nitride film with an oxygen source is performed at one or more temperatures ranging from or from about 100° C. to 400° C.