diazirinyl, dibenzisoquinolinyl, dibenzoacridinyl, dibenzocarbazolyl, dibenzofuranyl, dibenzophenazinyl, dibenzopyranonyl, dibenzopyronyl (xanthonyl), dibenzoquinoxalinyl, dibenzothiazepinyl, dibenzothiepinyl, dibenzothiophenyl, dibenzoxepinyl, dihydroazepinyl, dihydroazetyl, dihydrofuranyl, dihydrofuryl, dihydroisoquinolinyl, dihydropyranyl, dihydropyridinyl, dihydroypyridyl, dihydroquinolinyl, dihydrothienyl, dihydroindolyl, dioxanyl, dioxazinyl, dioxindolyl, dioxiranyl, dioxenyl, dioxinyl, dioxobenzofuranyl, dioxolyl, dioxotetrahydrofuranyl, dioxothiomorpholinyl, dithianyl, dithiazolyl, dithienyl, dithiinyl, furanyl, furazanyl, furoyl, furyl, guaninyl, homopiperazinyl, homopiperidinyl, hypoxanthinyl, hydantoinyl, imidazolidinyl, imidazolinyl, imidazolyl, indazolyl (e.g., 1H-indazolyl), indolenyl, indolinyl, indolizinyl, indolyl (e.g., 1H-indolyl or 3H-indolyl), isatinyl, isatyl, isobenzofuranyl, isochromanyl, isochromenyl, isoindazoyl, isoindolinyl, isoindolyl, isopyrazolonyl, isopyrazolyl, isoxazolidiniyl, isoxazolyl, isoquinolinyl, isothiazolidinyl, isothiazolyl, morpholinyl, naphthindazolyl, naphthindolyl, naphthiridinyl, naphthopyranyl, naphthothiazolyl, naphthothioxolyl, naphthotriazolyl, naphthoxindolyl, naphthyridinyl, octahydroisoquinolinyl, oxabicycloheptyl, oxauracil, oxadiazolyl, oxazinyl, oxaziridinyl, oxazolidinyl, oxazolidonyl, oxazolinyl, oxazolonyl, oxazolyl, oxepanyl, oxetanonyl, oxetanyl, oxetyl, oxtenayl, oxindolyl, oxiranyl, oxobenzoisothiazolyl, oxochromenyl, oxoisoquinolinyl, oxoquinolinyl, oxothiolanyl, phenanthridinyl, phenanthrolinyl, phenazinyl, phenothiazinyl, phenothienyl (benzothiofuranyl), phenoxathiinyl, phenoxazinyl, phthalazinyl, phthalazonyl, phthalidyl, phthalimidinyl, piperazinyl, piperidinyl, piperidonyl (e.g., 4-piperidonyl), pteridinyl, purinyl, pyranyl, pyrazinyl, pyrazolidinyl, pyrazolinyl, pyrazolopyrimidinyl, pyrazolyl, pyridazinyl, pyridinyl, pyridopyrazinyl, pyridopyrimidinyl, pyridyl, pyrimidinyl, pyrimidyl, pyronyl, pyrrolidinyl, pyrrolidonyl (e.g., 2-pyrrolidonyl), pyrrolinyl, pyrrolizidinyl, pyrrolyl (e.g., 2H-pyrrolyl), pyrylium, quinazolinyl, quinolinyl, quinolizinyl (e.g., 4H-quinolizinyl), quinoxalinyl, quinuclidinyl, selenazinyl, selenazolyl, selenophenyl, succinimidyl, sulfolanyl, tetrahydrofuranyl, tetrahydrofuryl, tetrahydroisoquinolinyl, tetrahydroisoquinolyl, tetrahydropyridinyl, tetrahydropyridyl (piperidyl), tetrahydropyranyl, tetrahydropyronyl, tetrahydroquinolinyl, tetrahydroquinolyl, tetrahydrothienyl, tetrahydrothiophenyl, tetrazinyl, tetrazolyl, thiadiazinyl (e.g., 6H-1,2,5-thiadiazinyl or 2H,6H-1,5,2-dithiazinyl), thiadiazolyl, thianthrenyl, thianyl, thianaphthenyl, thiazepinyl, thiazinyl, thiazolidinedionyl, thiazolidinyl, thiazolyl, thienyl, thiepanyl, thiepinyl, thietanyl, thietyl, thiiranyl, thiocanyl, thiochromanonyl, thiochromanyl, thiochromenyl, thiodiazinyl, thiodiazolyl, thioindoxyl, thiomorpholinyl, thiophenyl, thiopyranyl, thiopyronyl, thiotriazolyl, thiourazolyl, thioxanyl, thioxolyl, thymidinyl, thyminyl, triazinyl, triazolyl, trithianyl, urazinyl, urazolyl, uretidinyl, uretinyl, uricyl, uridinyl, xanthenyl, xanthinyl, xanthionyl, and the like, as well as modified forms thereof (e.g., including one or more oxo and/or

substituted amino. In other embodiments, the silyloxy group is -O-Si$(R)_a(OR)_b(NR_2)_c$, in which each R is, independently, H, optionally substituted aliphatic, optionally substituted heteroaliphatic, optionally substituted aromatic, or optionally substituted heteroaromatic; each of a, b, and $c \geq 0$; and $a + b + c = 3$. In particular embodiments, each R is, independently, H, optionally substituted alkyl, optionally substituted aryl, optionally substituted alkyl-aryl, or optionally substituted aryl-alkyl.

[0097] Use of the above terms is meant to encompass substituted and unsubstituted moieties. Substitution may be by one or more groups such as alcohols, ethers, esters, amides, sulfones, sulfides, hydroxyl, nitro, cyano, carboxy, amines, heteroatoms, lower alkyl, lower alkoxy, lower alkoxycarbonyl, alkoxyalkoxy, acyloxy, halogens, trifluoromethoxy, trifluoromethyl, alkyl, aralkyl, alkenyl, alkynyl, aryl, carboalkoxy, carboxyalkyl, cycloalkyl, cycloalkylalkyl, heterocyclyl, alkylheterocyclyl, heterocyclylalkyl, oxo, arylsulfonyl and aralkyaminocarbonyl, or any of the substituents of the preceding paragraphs or any of those substituents either directly attached or by suitable linkers. The linkers are typically short chains of 1-3 atoms containing any combination of -C-, -C(O)-, -NH-, -S-, -S(O)-, -O-, -C(O)- or
-S(O)O-. Rings may be substituted multiple times.

[0098] The term "lower" modifying "alkyl", "alkenyl", "alkynyl", "alkoxy" or "alkoxycarbonyl" refers to a C_1-C_6 unit for a particular functionality. For example, "lower alkyl" means C_1-C_6 alkyl.

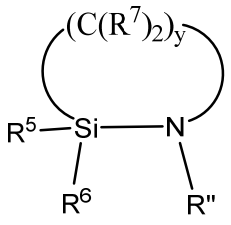
[0099] By "substituted" is meant having one or more substituent moieties whose presence does not interfere with the desired function or reactivity. Examples of substituents alkyl, alkenyl, alkynyl, cycloalkyl (non-aromatic ring), Si$(alkyl)_3$, Si$(alkoxy)_3$, alkoxy, amino, alkylamino, alkenylamino, amide, amidine, guanidine, hydroxyl, thioether, alkylcarbonyl, alkylcaronyloxy, alkoxycarbonyloxy, carbonate, alkoxycarbonyl, aminocarbonyl, alkylthiocarbonyl, phosphate, phosphate ester, phosphonato, cyano, halo, acylamino, imino, sulfhydryl, alkylthio, thiocarboxylate, dithiocarboxylate, sulfate, sulfato, sulfonate, sulfamoyl, sulfonamide, nitro, nitrile, azido, heterocyclyl, ether, ester, silicon-containing moieties, thioester or a combination thereof. The substituents may themselves be substituted. For instance, an amino substituent may itself be mono or independently disubstituted by further substituents defined above, such as alkyl, alkenyl, alkynyl, and cycloalkyl (non-aromatic ring).

[0100] By "thiocyanato" is meant -SCN.

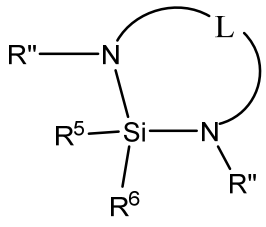
[0101] By "thioether" is meant to include to include both unidentate and multidentate (e.g. bidentate ot tridentate) thioethers, as well as ligands that contain both thioether and thiolate (or

[0160] In some embodiments, at least one of R' and R" is an optionally substituted haloaliphatic, haloalkyl, haloheteroaliphatic, halocyclic or haloaromatic group. Each R' may independently be hydrogen, -F, $-CF_3$, $-CH_2CF_3$, $-CH_2CHF_2$, $-CH_2CH_2F$, $-CHFCF_3$, $-CHFCHF_2$, $-CHFCH_2F$, $-C(F)=CF_2$, $-CF_2CF_3$, $-CF_2CH_3$, $-CF_2CHF_2$, or $-CF_2CH_2F$ in particular embodiments.

[0161] In the embodiment where two R″ can be taken together, with a nitrogen atom to which each is attached, to form an optionally substituted heterocyclyl, examples include structures of the formula (IIa) or (IIb)



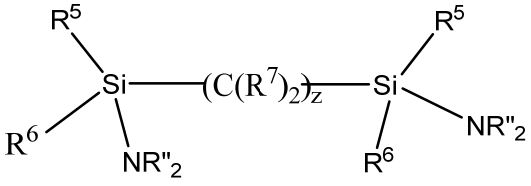
(IIa) or



(IIb)

wherein each R″ is independently H, halo, aliphatic, heteroaliphatic, aromatic, heteroaromatic, alkylsilyl or amino; R^5, R^6 and R^7 are each independently H, aliphatic, aliphatic-carbonyl, aliphatic-carbonyloxy, aliphatic-oxy, aliphatic-oxycarbonyl, heteroaliphatic, heteroaliphatic-carbonyl, heteroaliphatic-carbonyloxy, heteroaliphatic-oxy, heteroaliphatic-oxycarbonyl, aromatic, aromatic-carbonyl, aromatic-carbonyloxy, aromatic-oxy, aromatic-oxycarbonyl, heteroaromatic, heteroaromatic-oxy, amino, hydrazino, azido, hydroxyl, halo, silyl, silyloxy, cyanato, isocyanato, cyano, or isocyano; L is ethylene, 1,2-cyclohexanediyl, benzyl-2-yl, o-phenylene or 1,8-naphthylene; and y is an integer of 3 or 4.

[0162] Another useful class of precursors includes disilanes. One example is a structure of formula (III)



(III)

wherein each R″ is independently H, halo, aliphatic, heteroaliphatic, aromatic, heteroaromatic, alkylsilyl or amino; R^5, R^6 and R^7 are each independently H, aliphatic, aliphatic-carbonyl, aliphatic-carbonyloxy, aliphatic-oxy, aliphatic-oxycarbonyl, heteroaliphatic, heteroaliphatic-carbonyl, heteroaliphatic-carbonyloxy, heteroaliphatic-oxy, heteroaliphatic-oxycarbonyl, heterocyclyl, aromatic, aromatic-carbonyl, aromatic-carbonyloxy, aromatic-oxy, aromatic-oxycarbonyl, heteroaromatic, heteroaromatic-oxy, amino, amido, hydrazino, azido, hydroxyl, halo, silyl, silyloxy, alkoxy, cyanato, isocyanato, istothiocyanato, thiocyanato, cyano, or isocyano; and z is an integer of 0 to 3; and with the proviso that at least one of R", R^5, R^6 and R^7 is or includes fluorine, or that at least one of R", R^5, R^6 and R^7 includes carbon, or that at least one of R", R^5, R^6

390 may process a wafer 318. The processing chamber 314 is configured to deposit silicon oxide, deposit silicon nitride, anneal substrates using thermal or plasma anneals, and the like.

[0187] Tool 300 also includes a wafer transfer unit configured to transport wafers within the tool 300. Additional features of tool 300 will be discussed in greater detail below, and various features are discussed here with respect to some of the described techniques. In the depicted illustration, the wafer transfer unit includes a first robotic arm unit 326 in a first wafer transfer module and a second robotic arm unit 306 in a second wafer transfer module that may be considered an equipment front end module (EFEM) configured to received containers for wafers, such as a front opening unified module (FOUP) 308. The first robotic arm unit 326 is configured to transport a wafer between the processing chamber 314 and the second robotic arm unit via module 304 which may hold multiple wafers such as shown in module 302 with substrate 312. The second robotic arm unit 306 is configured to transport the wafer between a FOUP and module 304, or from module 302 to FOUP. After a wafer has been prepared in the module 304, the wafer transfer unit is able to transfer the wafer to first processing chamber 314 for deposition and optional anneal in situ.

[0188] Similar to above, the first wafer transfer module may a vacuum transfer module (VTM). Airlock or module 304, also known as a loadlock, is shown and may be individually optimized to perform various fabrication processes. The tool 300 also includes a FOUP 308 that is configured to lower the pressure of the tool 300 to a vacuum or low pressure, e.g., between about 1 mTorr and about 10 Torr, and maintain the tool 300 at this pressure. This includes maintaining the processing chamber 314, and the first wafer transfer module at the vacuum or low pressure. The second wafer transfer module may be at a different pressure, such as atmospheric. As the wafer is transferred throughout the tool 300, it is therefore maintained at the vacuum or low pressure.

[0189] In a further example, a substrate is placed in one of the FOUPs 308 and the second robot arm unit 306, or front-end robot, transfers the substrate from the FOUP 308 to an aligner, which allows the substrate to be properly centered before it is etched, or deposited upon, or otherwise processed. After being aligned, the substrate is moved by the second robot arm unit 306 into the airlock module 304. Because airlock modules have the ability to match the environment between an ATM and a VTM, the substrate is able to move between the two pressure environments without being damaged. From the airlock module 304, the substrate is moved by the first robot arm unit 326 through the first wafer transfer module, or VTM, and into the processing chamber 314. In order to achieve this substrate movement, the first robot arm unit 326 uses end effectors on each of its arms.

[0190] **Fig. 3** also depicts an embodiment of a system controller 350 employed to control process conditions and hardware states of process tool 300. System controller 350 may include one or

more memory devices 356, one or more mass storage devices 354, and one or more processors 352. Processor 352 may include a CPU or computer, analog and/or digital input/output connections, stepper motor controller boards, etc. In some embodiments, system controller 350 includes machine-readable instructions 358 for performing operations such as those described above with respect to **Fig. 2** and below with respect to **Fig. 4**.

[0191] As described above, one or more process stations may be included in a multi-station processing tool. **Fig. 4** depicts an example processing apparatus according to disclosed embodiments. Tool 400 includes a first processing chamber 402 and a second processing chamber 404. The first processing chamber 402 includes a plurality of processing stations, four stations 480A–D, that each may process a wafer. The first processing chamber 402 is configured to perform plasma treatment operations on the wafers. The second processing chamber 404 is configured to perform deposition on the wafer and may be considered a deposition chamber. The second processing chamber 404 also includes a plurality of processing stations, four stations 482A–D, that each may process a wafer. The first and second processing chambers 402 and 404 may be considered multi-station processing chambers.

[0192] Tool 400 also includes a wafer transfer unit configured to transport one or more wafers within the tool 400. Additional features of tool 400 will be discussed in greater detail below, and various features are discussed here with respect to some of the described techniques. In the depicted illustration, the wafer transfer unit includes a first robotic arm unit 408 in a first wafer transfer module 410 and a second robotic arm unit 412 in a second wafer transfer module 414 that may be considered an equipment front end module (EFEM) configured to received containers for wafers, such as a front opening unified module (FOUP) 416. The first robotic arm unit 408 is configured to transport a wafer between the first processing chamber 402 and the second processing chamber 404, and between the second processing chamber 404 and the second robotic arm unit 412. The second robotic arm unit 412 is configured to transport the wafer between a FOUP and the first robotic arm unit 408. After a wafer has been treated in the first processing chamber 402, the wafer transfer unit is able to transfer the wafer from the first processing chamber 402, to the second processing chamber 404 where one or more layers of encapsulation material may be deposited on one or more wafers.

[0193] Similar to above, the first wafer transfer module 410 may a vacuum transfer module (VTM). Airlock 420, also known as a loadlock or transfer module, is shown and may be individually optimized to perform various fabrication processes. The tool 400 also includes a FOUP 416 that is configured to lower the pressure of the tool 400 to a vacuum or low pressure, e.g., between about 1 mTorr and about 10 Torr, and maintain the tool 400 at this pressure. This

operation of the process tool components used to carry out various process tool processes. System control software may be coded in any suitable computer readable programming language.

[0197] In some embodiments, system control software may include input/output control (IOC) sequencing instructions for controlling the various parameters described above. Other computer software and/or programs stored on mass storage device and/or memory device associated with system controller 429 may be employed in some embodiments. Examples of programs or sections of programs for this purpose include a substrate positioning program, a process gas control program, a pressure control program, a heater control program, and a plasma control program.

[0198] A substrate positioning program may include program code for process tool components that are used to load the substrate onto pedestal and to control the spacing between the substrate and other parts of tool 400.

[0199] A process gas control program may include code for controlling gas composition (e.g., silicon-containing precursor gases, nitrogen-containing gases, carrier gases, inert gases, and/or purge gases as described herein) and flow rates and optionally for flowing gas into one or more process stations prior to deposition in order to stabilize the pressure in the process station. A pressure control program may include code for controlling the pressure in the process station by regulating, for example, a throttle valve in the exhaust system of the process station, a gas flow into the process station, etc.

[0200] A heater control program may include code for controlling the current to a heating unit that is used to heat the substrate. Alternatively, the heater control program may control delivery of a heat transfer gas (such as helium or nitrogen) to the substrate.

[0201] A plasma control program may include code for setting RF power levels applied to the process electrodes in one or more process stations in accordance with the embodiments herein.

[0202] A pressure control program may include code for maintaining the pressure in the reaction chamber in accordance with the embodiments herein.

[0203] In some embodiments, there may be a user interface associated with system controller 429. The user interface may include a display screen, graphical software displays of the apparatus and/or process conditions, and user input devices such as pointing devices, keyboards, touch screens, microphones, etc.

[0204] In some embodiments, parameters adjusted by system controller 429 may relate to process conditions. Non-limiting examples include process gas composition and flow rates, temperature, pressure, plasma conditions (such as RF bias power levels), etc. These parameters

CLAIMS

1. A method for deposition of a doped silicon oxide film, the method comprising:

(a) providing a substrate in a process chamber;

(b) exposing the substrate to a silicon-containing precursor, wherein the silicon- containing precursor comprises a fluorocarbosilane, fluorosilane, or a carbosilane, and wherein the silicon-containing precursor comprises one to five silicon atoms;

(c) purging the process chamber with an inert gas;

(d) exposing the substrate to a plasma of an oxidant or a plasma of a reducing agent;

(e) purging the process chamber with an inert gas; and

(f) depositing a doped silicon oxide film,

wherein the doped silicon oxide film comprises a film doped with N, C, F or a combination thereof;

wherein the method comprises one or more cycles of operations (a)-(f); and

wherein the doped silicon oxide film has a dielectric constant of about 3.9 or less.

2. The method of claim 1, wherein the fluorosilane comprises a fluoro carboaminosilane precursor or a fluoroaminosilane precursor.

3. The method of claim 1, wherein the fluorosilane comprises a direct silicon-fluorine bond, fluorine connected to silicon through a linker, or a direct silicon-fluorine bond and fluorine connected to silicon through a linker, and optionally wherein the linker comprises alkyl, aryl, amino or heterocyclyl.

4. The method of claim 1, wherein the silicon-containing precursor is a halogenated precursor comprising at least one fluorine, and optionally wherein the halogenated precursor further comprises one or more halogens, wherein each of the one or more halogens is selected from the group consisting of chlorine, bromine, and iodine.

5. The method of claim 1, wherein the carbosilane comprises a fluorocarboaminosilane precursor, a fluorocarbosilane precursor, or a carboaminosilane precursor.

6. The method of claim 1, wherein the carbosilane comprises octamethylcyclotetrasiloxane, tetravinylmethylcyclotetrasiloxane, tetramethylcyclotetrasiloxane, tetraethylorthosilicate, tetramethylorthosilicate, pentamethylcyclopentasiloxane or hexamethylcyclotrisiloxane.

7. The method of claim 1, wherein the doped silicon oxide film further comprises a film doped with B, P, Sb, Ga or a combination thereof.

8. The method of claim 1, wherein the oxidant comprises oxygen, water, nitrous oxide, carbon dioxide, ozone, hydrogen peroxide or a combination thereof.

9. The method of claim 1, wherein exposing the substrate to the oxidant comprises flowing the oxidant in an inert gas comprising argon, nitrogen, neon, krypton, helium or a combination thereof.

10. The method of claim 1, wherein purging is performed by delivering an inert gas comprising argon, nitrogen, neon, krypton, helium or a combination thereof.

11. A method for deposition of a doped silicon oxide film, the method comprising:

(a) providing a substrate in a process chamber;

(b) exposing the substrate to a silicon-containing precursor, wherein the silicon-containing precursor includes at least one Si-F bond, at least one Si-C bond, or at least one Si-C bond and at least one Si-F bond and wherein the silicon-containing precursor comprises one to five silicon atoms;

(c) purging the process chamber with an inert gas;

(d) exposing the substrate to a plasma of an oxidant or a plasma of a reducing agent;

(e) purging the process chamber with an inert gas; and

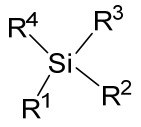
(f) depositing a doped silicon oxide film,

wherein the doped silicon oxide film comprises a film doped with C, F or a combination thereof;

wherein the method comprises one or more cycles of operations (a)-(f); and

wherein the doped silicon oxide film has a dielectric constant of about 3.9 or less.

12. The method of claim 11, wherein the silicon-containing precursor comprises a structure of formula (I):



(I),

wherein:

R^1, R^2, R^3 and R^4 each independently comprise H, aliphatic, aliphatic-carbonyl, aliphatic-carbonyloxy, aliphatic-oxy, aliphatic-oxycarbonyl, heteroaliphatic, heteroaliphatic-carbonyl, heteroaliphatic-carbonyloxy, heteroaliphatic-oxy, heteroaliphatic-oxycarbonyl, aromatic, aromatic-carbonyl, aromatic-carbonyloxy, aromatic-oxy, aromatic-oxycarbonyl, heteroaromatic, heteroaromatic-oxy, heterocyclyl, amino, amido, hydrazino, azido, hydroxyl, halo, silyl, silyloxy, alkoxy, cyanato, isocyanato, isothiocyanato, thiocyanato, cyano, or isocyano; and

R^1 and R^2 may be linked to form a ring, or wherein R^1, R^2 and R^3 may be linked to form a ring, with the proviso that

at least one of R^1, R^2, R^3 and R^4 is or comprises fluorine,

or that at least one of R^1, R^2, R^3 and R^4 comprises carbon,

or that at least one of R^1, R^2, R^3 and R^4 is or comprises fluorine and at least one of R^1, R^2, R^3 and R^4 comprises carbon.

13. The method of claim 11, wherein the silicon-containing precursor comprises a structure of formula (II):

$$(R')_{4-x}Si(NR''_2)_x \quad (II),$$

wherein:

x is 1, 2, 3, or 4;

each R′ independently comprises H, aliphatic, aliphatic-carbonyl, aliphatic-carbonyloxy, aliphatic-oxy, aliphatic-oxycarbonyl, heteroaliphatic, heteroaliphatic-carbonyl, heteroaliphatic-carbonyloxy, heteroaliphatic-oxy, heteroaliphatic-oxycarbonyl, aromatic, aromatic-carbonyl, aromatic-carbonyloxy, aromatic-oxy, aromatic-oxycarbonyl, heteroaromatic, heteroaromatic-oxy, heterocyclyl, amino, amido, hydrazino, azido, hydroxyl, halo, silyl, silyloxy, alkoxy, cyanato, isocyanato, isothiocyanato, thiocyanato, cyano, or isocyano; and

each R″ independently comprises H, halo, aliphatic, heteroaliphatic, aromatic, heteroaromatic, alkylsilyl or amino; or optionally wherein two R″ can be taken together, with a nitrogen atom to which each is attached, to form an optionally substituted heterocyclyl,

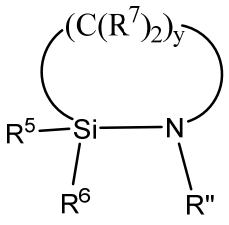
with the proviso that

at least one of R' and R" is or comprises fluorine,

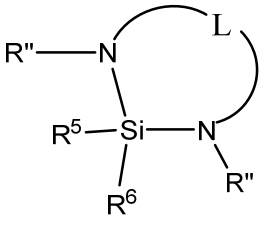
or that at least one of R' and R" comprises carbon,

or that at least one of R' and R" is or comprises fluorine and at least one of R' and R" comprises carbon.

14. The method of claim 13, wherein two R″ can be taken together, with a nitrogen atom to which each is attached, to form an optionally substituted heterocyclyl of formula (IIa) or (IIb):



(IIa) or



(IIb),

wherein:

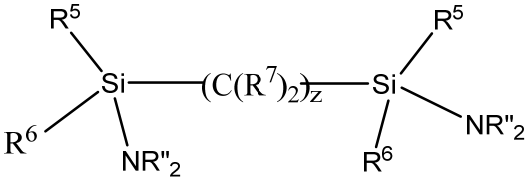
each R″ independently comprises H, halo, aliphatic, heteroaliphatic, aromatic, heteroaromatic, alkylsilyl or amino;

R^5, R^6 and R^7 each independently comprise H, aliphatic, aliphatic-carbonyl, aliphatic-carbonyloxy, aliphatic-oxy, aliphatic-oxycarbonyl, heteroaliphatic, heteroaliphatic-carbonyl, heteroaliphatic-carbonyloxy, heteroaliphatic-oxy, heteroaliphatic-oxycarbonyl, aromatic, aromatic-carbonyl, aromatic-carbonyloxy, aromatic-oxy, aromatic-oxycarbonyl, heteroaromatic, heteroaromatic-oxy, amino, hydrazino, azido, hydroxyl, halo, silyl, silyloxy, cyanato, isocyanato, cyano, or isocyano;

L comprises ethylene, 1,2-cyclohexanediyl, benzyl-2-yl, o-phenylene or 1,8-naphthylene;

and y is an integer of 3 or 4.

15. The method of claim 11, wherein the silicon-containing precursor comprises a structure of formula (III):



(III),

wherein:

each R″ independently comprises H, halo, aliphatic, heteroaliphatic, aromatic, heteroaromatic, alkylsilyl or amino;

R^5, R^6 and R^7 each independently comprise H, aliphatic, aliphatic-carbonyl, aliphatic-carbonyloxy, aliphatic-oxy, aliphatic-oxycarbonyl, heteroaliphatic, heteroaliphatic-carbonyl, heteroaliphatic-carbonyloxy, heteroaliphatic-oxy, heteroaliphatic-oxycarbonyl, aromatic, aromatic-carbonyl, aromatic-carbonyloxy, aromatic-oxy, aromatic-oxycarbonyl, heteroaromatic, heteroaromatic-oxy, amino, amido, hydrazino, azido, hydroxyl, halo, silyl, silyloxy, alkoxy, heterocyclyl, cyanato, isothiocyanato, thiocyanato, isocyanato, cyano, or isocyano; and

z is an integer of 0 to 3,

with the proviso that

at least one of R", R^5, R^6 and R^7 is or comprises fluorine,

or that at least one of R", R^5, R^6 and R^7 comprises carbon,

or that at least one of R", R^5, R^6 and R^7 is or comprises fluorine and at least one of R", R^5, R^6 and R^7 comprises carbon.

16. An apparatus for deposition of a doped silicon oxide film, the apparatus comprising:

one or more process chambers comprising a substrate support;

a plasma generator;

one or more process gas sources connected with the process chamber and flow-control hardware; and

a controller having at least one processor and a memory, wherein:

the at least one processor and the memory are communicatively connected with one another, the at least one processor is at least operatively connected with the flow-control hardware, and the memory stores computer-executable instructions for controlling the at least one processor to at least control the flow-control hardware to perform the method of claim 1.