THE FOLLOWING IS CLAIMED

1) A method for forming a silicon nitride or carbon-doped silicon nitride via a plasma enhanced ALD process, the method comprising:

a) providing a substrate comprising a surface feature in a reactor and heating the reactor to one or more temperatures ranging up to 600°C, and optionally maintaining the reactor at a pressure of 100 torr or less;

b) introducing into the reactor at least one silicon precursor having one or two Si-C-Si linkages and selected from the group consisting of 1,1,1,3,3-pentachloro-1,3-disilabutane, 1,1,1,3,3-pentachloro-2-methyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-2,2-dimethyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-2-ethyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-1,3-disilapentane, 1,1,1,3,3-pentachloro-2-methyl-1,3-disilapentane, 1,1,1,3,3-pentxachloro-2,2-dimethyl-1,3-disilapentane, 1,1,1,3,3-pentachloro-2-ethyl-1,3-disilapentane, 1,1,1,3,3,5,5-heptachloro-1,3,5-trisilahexane, 1,1,1,5,5-pentachloro-3,3-dimethyl-1,3,5-trisilahexane, 1,1,1,5,5-pentachloro-1,3,5-trisilahexane, 2,2,4,6,6-pentachloro-4-methyl-2,4,6-trisilaheptane, whereby the silicon precursor reacts on at least a portion of the surface feature of the substrate to provide a chemisorbed layer;

c) purging the reactor of any unreacted silicon precursors and/or any reaction by-products using inert gas;

d) providing a plasma comprising an ammonia source into the reactor to react with the chemisorbed layer to form a silicon nitride film; and

e) purging the reactor of any further reaction by-products with inert gas;

wherein the steps b through e are repeated until a desired thickness of the silicon nitride film is deposited.

2) The method according to claim 1, wherein the silicon nitride film is a carbon-doped silicon nitride film.

3) The method according to claim 1, further comprising:

treating the silicon nitride film with a spike anneal at a temperature ranging between 400 and 1000°C.

4) The method according to claim 1, further comprising:

exposing the silicon nitride film to a UV light source either during or after deposition of the silicon nitride film.

5) The method according to claim 1, further comprising:

exposing the silicon nitride film to a plasma comprising one or more gases selected from the group consisting of hydrogen, inert gas, nitrogen, and combinations thereof.

6) The method according to claim 1, further comprising:

treating the silicon nitride film with an oxygen source at one or more temperatures ranging from ambient temperature to 1000 °C to convert the silicon nitride into a silicon oxynitride film, either in situ or in a separate chamber from the reactor.

7) The method according to claim 6, wherein the silicon nitride film is a carbon-doped silicon nitride film, and wherein the step of treating the silicon nitride film with an oxygen source converts the carbon-doped silicon nitride into a carbon-doped silicon oxynitride film.

8) The method according to claim 1, wherein the film has a dielectric constant (k) of 6 or less, and a carbon content of 5 atomic weight % or less as measured by X-ray photoelectron spectroscopy.

9) The method according to claim 8, wherein the film has a carbon content of 3 atomic weight percent or less as measured by X-ray photoelectron spectroscopy.

10) The method according to claim 9, wherein the film has a carbon content of 2 atomic weight percent or less as measured by X-ray photoelectron spectroscopy.

11) The method according to claim 10, wherein the film has a carbon content of 1 atomic weight percent or less as measured by X-ray photoelectron spectroscopy.

12) The method of claim 1 further comprising performing a thermal anneal on the silicon nitride or carbon-doped silicon nitride film at temperatures from 300 to 1000°C.

13) The method of claim 1 further comprising performing a plasma treatment on the silicon nitride film with an inert gas plasma or hydrogen/inert plasma or nitrogen plasma at a temperature ranging between 25°C and 600°C.

14) The method of claim 2 further comprising performing a plasma treatment on the carbon-doped silicon nitride film with an inert gas plasma or hydrogen/inert plasma or nitrogen plasma at a temperature ranging between 25°C and 600°C.

15) The method of claim 6 further comprising performing a plasma treatment on the silicon oxynitride film with an inert gas plasma or hydrogen/inert plasma or nitrogen plasma at a temperature ranging between 25°C and 600°C.

16) The method of claim 7 further comprising performing a plasma treatment on the carbon-doped silicon oxynitride film with an inert gas plasma or hydrogen/inert plasma or nitrogen plasma at a temperature ranging between 25°C and 600°C.

17) A method for forming a silicon nitride or carbon-doped silicon nitride via a plasma enhanced ALD process, the method comprising:

a) providing a substrate comprising a surface feature in a reactor;

b) introducing into the reactor at least one silicon precursor having one or two Si-C-Si linkages and selected from the group consisting of 1,1,1,3,3-pentachloro-1,3-disilabutane, 1,1,1,3,3-pentachloro-2-methyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-2,2-dimethyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-2-ethyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-1,3-disilapentane, 1,1,1,3,3-pentachloro-2-methyl-1,3-disilapentane, 1,1,1,3,3-pentxachloro-2,2-dimethyl-1,3-disilapentane, 1,1,1,3,3-pentachloro-2-ethyl-1,3-disilapentane, 1,1,1,3,3,5,5-heptachloro-1,3,5-trisilahexane, 1,1,1,5,5-pentachloro-3,3-dimethyl-1,3,5-trisilahexane, 1,1,1,5,5-pentachloro-1,3,5-trisilahexane, and 2,2,4,6,6-pentachloro-4-methyl-2,4,6-trisilaheptane whereby the silicon precursor reacts on at least a portion of the surface feature of the substrate to provide a chemisorbed layer;

c) purging the reactor of any unreacted silicon precursors and/or any reaction by-products, using inert gas;

d) providing a first plasma source into the reactor to react with the chemisorbed layer to form a silicon nitride film that is optionally carbon-doped;

e) purging the reactor of any further reaction by-products using inert gas;

f) providing a second plasma source into the reactor to further react and form the silicon nitride film that is optionally carbon-doped;

g) purging the reactor of any further reaction by-products using inert gas;

wherein the steps b through g are repeated until the silicon nitride film that is optionally carbon-doped reaches a desired thickness, and wherein the reactor is maintained at one or more temperatures ranging from 25°C to 600°C.

18) The method according to claim 17, wherein the plasma is a plasma comprising an ammonia source and the second plasma is a plasma comprising a nitrogen source.

19) The method according to claim 17, wherein the first plasma is a plasma comprising a nitrogen source and the second plasma is a plasma comprising an ammonia source.

20) A stainless steel container housing a composition comprising at least one silicon precursor having one or two Si-C-Si linkages and selected from the group consisting of 1,1,1,3,3-pentachloro-1,3-disilabutane, 1,1,1,3,3-pentachloro-2-methyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-2,2-dimethyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-2-ethyl-1,3-disilabutane, 1,1,1,3,3-pentachloro-1,3-disilapentane, 1,1,1,3,3-pentachloro-2-methyl-1,3-disilapentane, 1,1,1,3,3-pentxachloro-2,2-dimethyl-1,3-disilapentane, 1,1,1,3,3-pentachloro-2-ethyl-1,3-disilapentane, 1,1,1,3,3,5,5-heptachloro-1,3,5-trisilahexane, 1,1,1,5,5-pentachloro-3,3-dimethyl-1,3,5-trisilahexane, 1,1,1,5,5-pentachloro-1,3,5-trisilahexane, and 2,2,4,6,6-pentachloro-4-methyl-2,4,6-trisilaheptane.

21) The stainless steel container of claim 20 further housing an inert head-space gas selected from the group consisting of helium, argon, nitrogen and combinations thereof.

22) The method according to claim 1, wherein the silicon nitride or carbon-doped silicon nitride film is suitable for semiconductor industry or display applications.

23) The method according to claim 17, wherein the silicon nitride or carbon-doped silicon nitride film is suitable for semiconductor industry or display applications.