CLAIMS

1. A method for depositing a silicon-containing film in a flowable chemical vapor deposition process, the method comprising:

placing a substrate comprising a surface feature into a reactor which is at one or more temperatures ranging from -20°C to 100°C;

introducing into the reactor a composition comprising at least one compound having the formula $R_nSiR^1_{4-n}$ wherein R is selected from a linear or branched C_2 to C_6 alkenyl group, a linear or branched C_2 to C_6 alkynyl group; R^1 is selected from hydrogen, methane and a linear or branched C_2 to C_{10} alkyl group; and n is a number selected from 1, 2, 3 and 4;

providing a plasma source into the reactor to at least partially react the at least one compound to form a flowable liquid oligomer, wherein the flowable liquid oligomer at least partially fills at least a portion of the surface feature, and wherein the plasma source comprises both a remote plasma source and an in-situ plasma source operating in combination.

2. The method of claim 1 wherein at least one of the remote plasma source and the in-situ plasma source comprises a plasma source selected from the group consisting of nitrogen plasma, a plasma comprising nitrogen and hydrogen, a plasma comprising nitrogen and helium, a plasma comprising nitrogen and argon, ammonia plasma, a plasma comprising ammonia and helium, a plasma comprising ammonia and argon, a plasma comprising ammonia and nitrogen, NF_3 plasma, organic amine plasma, and mixtures thereof.

3. The method of claim 1 wherein at least one of the remote plasma source and the in-situ plasma source comprises a carbon source plasma, selected from the group consisting of a hydrocarbon plasma, a plasma comprising hydrocarbon and helium, a plasma comprising hydrocarbon and argon, carbon dioxide plasma, carbon monoxide plasma, a plasma comprising hydrocarbon and hydrogen, a plasma comprising hydrocarbon

and a nitrogen source, a plasma comprising hydrocarbon and an oxygen source, and mixture thereof.

4. The method of claim 1 wherein at least one of the remote plasma source and the in-situ plasma source is selected from the group consisting of hydrogen plasma, helium plasma, argon plasma, xenon plasma, and mixture thereof.

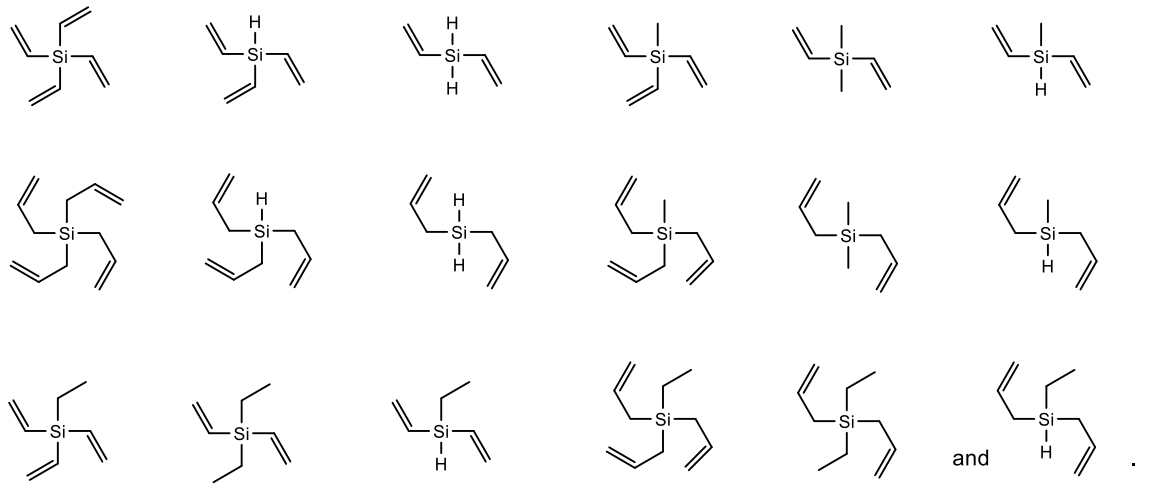
5. The method of claim 1 wherein at least one of the remote plasma source and the in-situ plasma source comprises a plasma source comprising oxygen selected from the group consisting of water (H_2O) plasma, oxygen plasma, ozone (O_3) plasma, NO plasma, N_2O plasma, carbon monoxide (CO) plasma, carbon dioxide (CO_2) plasma and combinations thereof.

6. The method of claim 1 further comprising treating the flowable liquid oligomer at one or more temperatures ranging from 100 ^oC to 1000 ^oC to cure the flowable liquid oligomer and form a hardened film.

7. The method of claim 1 wherein a pressure of the reactor is maintained at 100 torr or less.

8. The method of claim 1 wherein the silicon-containing film is selected from the group consisting of silicon carbide, silicon nitride, silicon oxide, carbon doped silicon nitride, carbon doped silicon oxide, silicon oxynitride, and carbon doped silicon oxynitride film.

9. The method of claim 1 wherein the at least one compound is selected from the group consisting of



10. The method of claim 9 wherein the at least one compound comprises tetravinylsilane.