CLAIMS

1. A composition for forming a silicon-containing film, the composition comprising a silazane precursor selected from the group consisting of 1,1,1,3,3,3-hexachloro-2-methyldisilazane, 1,1,1,3,3,3-hexachloro-2-n-propyldisilazane, 1,1,1,3,3,3-hexachloro-2-iso-propyldisilazane, 1,1,1,3,3,3-hexachloro-2-n-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-iso-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-sec-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-tert-butyldisilazane, 1,1,1,3,3-pentachloro-2-methyldisilazane, 1,1,1,3,3-pentachloro-2-ethyldisilazane, 1,1,1,3,3-pentachloro-2-n-propyldisilazane, 1,1,1,3,3-pentachloro-2-iso-propyldisilazane, 1,1,1,3,3-pentachloro-2-methyl-3-methyl-disilazane, 1,1,1,3,3-pentachloro-2-ethyl-3-methyldisilazane, 1,1,1,3,3-pentachloro-2-n-propyl-3-methyldisilazane, 1,1,1,3,3-pentachloro-2-iso-propyl-3-methyldisilazane, 1,1,1,3,3,3-hexabromo-2-methyldisilazane, 1,1,1,3,3,3-bromo-2-ethyldisilazane, 1,1,1,3,3,3-bromo-2-n-propyldisilazane, 1,1,1,3,3,3-bromo-2-iso-propyldisilazane, 1,1,1,3,3,3-bromo-2-n-butyldisilazane, 1,1,1,3,3,3-bromo-2-sec-butyldisilazane, 1,1,1,3,3,3-bromo-2-iso-butyldisilazane, 1,1,1,3,3,3-bromo-2-tert-butyldisilazane, 1,1,1,3,3,3-hexaiodo-2-methyldisilazane, 1,1,1,3,3,3-iodo-2-ethyldisilazane, 1,1,1,3,3,3-iodo-2-n-propyldisilazane, 1,1,1,3,3,3-iodo-2-n-butyldisilazane, 1,1,1,3,3,3-iodo-2-iso-propyldisilazane, 1,1,1,3,3,3-iodo-2-iso-butyldisilazane, 1,1,1,3,3,3-iodo-2-sec-butyl-disilazane, 1,1,1,3,3,3-iodo-2-tert-butyl-disilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-tetrachloro-2-ethyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-n-propyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-iso-propyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-n-butyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-iso-butyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-sec-butyldisilazane, and 1,1,3,3-tetrachloro-1,3-dimethyl-2-tert-butyldisilazane, 1,1,3,3-tetrachloro-2-methyldisilazane , 1,1,3,3-tetrachloro-2-ethyldisilazane, 1,1,3,3-tetrachloro-2-n-propyldisilazane, 1,1,3,3-tetrachloro-2-iso-propyldisilazane, 1,1,3,3-tetrachloro-2-n-butyldisilazane, 1,1,3,3-tetrachloro-2-iso-butyldisilazane, 1,1,3,3-tetrachloro-2-sec-butyldisilazane, 1,1,3,3-tetrachloro-2-tert-butyldisilazane, 1,1,3,3-tetrabromo-2-methyldisilazane, 1,1,3,3-tetrabromo-2-ethyldisilazane, 1,1,3,3-tetrabromo-2-n-propyldisilazane, 1,1,3,3-tetrabromo-2-iso-propyldisilazane, 1,1,3,3-tetrabromo-2-n-butyldisilazane, 1,1,3,3-tetrabromo-2-iso-butyldisilazane, 1,1,3,3-tetrabromo-2-sec-butyldisilazane, 1,1,3,3-tetrabromo-2-tert-butyldisilazane, 1,1,3,3-tetraiodo-2-methyldisilazane, 1,1,3,3-tetraiodo-2-ethyldisilazane, 1,1,3,3-tetraiodo-2-n-propyldisilazane, 1,1,3,3-tetraiodo-2-iso-propyldisilazane, 1,1,3,3-

tetraiodo-2-n-butyldisilazane, 1,1,3,3-tetraiodo-2-iso-butyldisilazane, 1,1,3,3-tetraiodo-2-sec-butyldisilazane, 1,1,3,3-tetraiodo-2-tert-butyldisilazane, 1,1,3,3-tetrachloro-2-cyclopentyldisilazane, 1,1,3,3-tetrachloro-2-cyclohexyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-cyclopentyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-cyclohexyldisilazane, and

wherein the composition is free of organoamines, halide ions, metal ions.

2. A composition for forming a silicon-containing film, the composition comprising:

(a) at least one silazane selected from the group consisting of 1,1,1,3,3,3-hexachloro-2-methyldisilazane, 1,1,1,3,3,3-hexachloro-2-ethyldisilazane, 1,1,1,3,3,3-hexachloro-2-n-propyldisilazane, 1,1,1,3,3,3-hexachloro-2-iso-propyldisilazane, 1,1,1,3,3,3-hexachloro-2-n-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-iso-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-sec-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-tert-butyldisilazane, 1,1,1,3,3-pentachloro-2-methyldisilazane, 1,1,1,3,3-pentachloro-2-ethyldisilazane, 1,1,1,3,3-pentachloro-2-n-propyldisilazane, 1,1,1,3,3-pentachloro-2-iso-propyldisilazane, 1,1,1,3,3-pentachloro-2-methyl-3-methyl-disilazane, 1,1,1,3,3-pentachloro-2-ethyl-3-methyldisilazane, 1,1,1,3,3-pentachloro-2-n-propyl-3-methyldisilazane, 1,1,1,3,3-pentachloro-2-iso-propyl-3-methyldisilazane, 1,1,1,3,3,3-hexabromo-2-methyldisilazane, 1,1,1,3,3,3-bromo-2-ethyldisilazane, 1,1,1,3,3,3-bromo-2-n-propyldisilazane, 1,1,1,3,3,3-bromo-2-iso-propyldisilazane, 1,1,1,3,3,3-bromo-2-n-butyldisilazane, 1,1,1,3,3,3-bromo-2-sec-butyldisilazane, 1,1,1,3,3,3-bromo-2-iso-butyldisilazane, 1,1,1,3,3,3-bromo-2-tert-butyldisilazane, 1,1,1,3,3,3-hexaiodo-2-methyldisilazane, 1,1,1,3,3,3-iodo-2-ethyldisilazane, 1,1,1,3,3,3-iodo-2-n-propyldisilazane, 1,1,1,3,3,3-iodo-2-n-butyldisilazane, 1,1,1,3,3,3-iodo-2-iso-propyldisilazane, 1,1,1,3,3,3-iodo-2-iso-butyldisilazane, 1,1,1,3,3,3-iodo-2-sec-butyl-disilazane, 1,1,1,3,3,3-iodo-2-tert-butyl-disilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-methyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-tetrachloro-2-ethyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-n-propyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-iso-propyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-n-butyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-iso-butyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-sec-butyldisilazane, and 1,1,3,3-tetrachloro-1,3-dimethyl-2-tert-butyldisilazane, 1,1,3,3-tetrachloro-2-methyldisilazane , 1,1,3,3-tetrachloro-2-ethyldisilazane, 1,1,3,3-tetrachloro-2-n-

propyldisilazane, 1,1,3,3-tetrachloro-2-iso-propyldisilazane, 1,1,3,3-tetrachloro-2-n-butyldisilazane, 1,1,3,3-tetrachloro-2-iso-butyldisilazane, 1,1,3,3-tetrachloro-2-sec-butyldisilazane, 1,1,3,3-tetrachloro-2-tert-butyldisilazane, 1,1,3,3-tetrabromo-2-methyldisilazane, 1,1,3,3-tetrabromo-2-ethyldisilazane, 1,1,3,3-tetrabromo-2-n-propyldisilazane, 1,1,3,3-tetrabromo-2-iso-propyldisilazane, 1,1,3,3-tetrabromo-2-n-butyldisilazane, 1,1,3,3-tetrabromo-2-iso-butyldisilazane, 1,1,3,3-tetrabromo-2-sec-butyldisilazane, 1,1,3,3-tetrabromo-2-tert-butyldisilazane, 1,1,3,3-tetraiodo-2-methyldisilazane, 1,1,3,3-tetraiodo-2-ethyldisilazane, 1,1,3,3-tetraiodo-2-n-propyldisilazane, 1,1,3,3-tetraiodo-2-iso-propyldisilazane, 1,1,3,3-tetraiodo-2-n-butyldisilazane, 1,1,3,3-tetraiodo-2-iso-butyldisilazane, 1,1,3,3-tetraiodo-2-sec-butyldisilazane, 1,1,3,3-tetraiodo-2-tert-butyldisilazane, 1,1,3,3-tetrachloro-2-cyclopentyldisilazane, 1,1,3,3-tetrachloro-2-cyclohexyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-cyclopentyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-cyclohexyldisilazane; and

(b) a solvent, wherein the solvent has a boiling point, wherein the difference between the boiling point of the solvent and that of the at least one silazane is 40°C or less, and wherein the composition is substantially free of organoamines, halide ions, and metal ions.

3. The composition of claim 2 wherein the solvent comprises at least one selected from the group consisting of ether, tertiary amine, alkyl hydrocarbon, aromatic hydrocarbon, and tertiary aminoether.

4. A method for forming a silicon-containing film on at least one surface of a substrate by a deposition process selected from a chemical vapor deposition process and an atomic layer deposition process, the method comprising:

providing the at least one surface of the substrate in a reaction chamber;

introducing at least one silazane precursor selected from the group consisting of 1,1,1,3,3,3-hexachloro-2-methyldisilazane, 1,1,1,3,3,3-hexachloro-2-ethyldisilazane, 1,1,1,3,3,3-hexachloro-2-n-propyldisilazane, 1,1,1,3,3,3-hexachloro-2-iso-propyldisilazane, 1,1,1,3,3,3-hexachloro-2-n-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-

iso-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-sec-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-tert-butyldisilazane, 1,1,1,3,3-pentachloro-2-methyldisilazane, 1,1,1,3,3-pentachloro-2-ethyldisilazane, 1,1,1,3,3-pentachloro-2-n-propyldisilazane, 1,1,1,3,3-pentachloro-2-iso-propyldisilazane, 1,1,1,3,3-pentachloro-2-methyl-3-methyl-disilazane, 1,1,1,3,3-pentachloro-2-ethyl-3-methyldisilazane, 1,1,1,3,3-pentachloro-2-n-propyl-3-methyldisilazane, 1,1,1,3,3-pentachloro-2-iso-propyl-3-methyldisilazane, 1,1,1,3,3,3-hexabromo-2-methyldisilazane, 1,1,1,3,3,3-bromo-2-ethyldisilazane, 1,1,1,3,3,3-bromo-2-n-propyldisilazane, 1,1,1,3,3,3-bromo-2-iso-propyldisilazane, 1,1,1,3,3,3-bromo-2-n-butyldisilazane, 1,1,1,3,3,3-bromo-2-sec-butyldisilazane, 1,1,1,3,3,3-bromo-2-iso-butyldisilazane, 1,1,1,3,3,3-bromo-2-tert-butyldisilazane, 1,1,1,3,3,3-hexaiodo-2-methyldisilazane, 1,1,1,3,3,3-iodo-2-ethyldisilazane, 1,1,1,3,3,3-iodo-2-n-propyldisilazane, 1,1,1,3,3,3-iodo-2-n-butyldisilazane, 1,1,1,3,3,3-iodo-2-iso-propyldisilazane, 1,1,1,3,3,3-iodo-2-iso-butyldisilazane, 1,1,1,3,3,3-iodo-2-sec-butyl-disilazane, 1,1,1,3,3,3-iodo-2-tert-butyl-disilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-methyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-tetrachloro-2-ethyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-n-propyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-iso-propyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-n-butyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-iso-butyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-sec-butyldisilazane, and 1,1,3,3-tetrachloro-1,3-dimethyl-2-tert-butyldisilazane, 1,1,3,3-tetrachloro-2-methyldisilazane , 1,1,3,3-tetrachloro-2-ethyldisilazane, 1,1,3,3-tetrachloro-2-n-propyldisilazane, 1,1,3,3-tetrachloro-2-iso-propyldisilazane, 1,1,3,3-tetrachloro-2-n-butyldisilazane, 1,1,3,3-tetrachloro-2-iso-butyldisilazane, 1,1,3,3-tetrachloro-2-sec-butyldisilazane, 1,1,3,3-tetrachloro-2-tert-butyldisilazane, 1,1,3,3-tetrabromo-2-methyldisilazane, 1,1,3,3-tetrabromo-2-ethyldisilazane, 1,1,3,3-tetrabromo-2-n-propyldisilazane, 1,1,3,3-tetrabromo-2-iso-propyldisilazane, 1,1,3,3-tetrabromo-2-n-butyldisilazane, 1,1,3,3-tetrabromo-2-iso-butyldisilazane, 1,1,3,3-tetrabromo-2-sec-butyldisilazane, 1,1,3,3-tetrabromo-2-tert-butyldisilazane, 1,1,3,3-tetraiodo-2-methyldisilazane, 1,1,3,3-tetraiodo-2-ethyldisilazane, 1,1,3,3-tetraiodo-2-n-propyldisilazane, 1,1,3,3-tetraiodo-2-iso-propyldisilazane, 1,1,3,3-tetraiodo-2-n-butyldisilazane, 1,1,3,3-tetraiodo-2-iso-butyldisilazane, 1,1,3,3-tetraiodo-2-sec-butyldisilazane, 1,1,3,3-tetraiodo-2-tert-butyldisilazane, 1,1,3,3-tetrachloro-2-cyclopentyldisilazane, 1,1,3,3-tetrachloro-2-cyclohexyldisilazane, 1,1,3,3-tetrachloro-1,3,-dimethyl-2-cyclopentyldisilazane, and 1,1,3,3-tetrachloro-1,3-dimethyl-2-cyclohexyldisilazane; and

introducing a nitrogen-containing source into the reactor wherein the at least one silazane precursor and the nitrogen-containing source react to form the film on the at least one surface, wherein the silazane is substantially free of organoamines, halide ions, and metal ions.

5. The method of claim 4 wherein the nitrogen-containing source is selected from the group consisting of ammonia, hydrazine, monoalkylhydrazine, dialkylhydrazine, nitrogen, nitrogen/hydrogen, ammonia plasma, nitrogen plasma, nitrogen/hydrogen plasma, and mixtures thereof.

6. The method of claim 4 wherein the silicon-containing film is selected from the group consisting of silicon nitride and silicon carbonitride.

7. A method of forming a silicon-containing film wherein the film is selected from an amorphous and a crystalline film from a deposition process selected from by plasma enhanced atomic layer deposition and plasma enhanced cyclic chemical vapor deposition, the method comprising:

placing one or more substrates into a reactor which is heated to one or more temperatures ranging from ambient temperature to about 1000°C;

introducing at least one silazane precursor selected from the group consisting of 1,1,1,3,3,3-hexachloro-2-methyldisilazane, 1,1,1,3,3,3-hexachloro-2-ethyldisilazane, 1,1,1,3,3,3-hexachloro-2-n-propyldisilazane, 1,1,1,3,3,3-hexachloro-2-iso-propyldisilazane, 1,1,1,3,3,3-hexachloro-2-n-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-iso-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-sec-butyldisilazane, 1,1,1,3,3,3-hexachloro-2-tert-butyldisilazane, 1,1,1,3,3-pentachloro-2-methyldisilazane, 1,1,1,3,3-pentachloro-2-ethyldisilazane, 1,1,1,3,3-pentachloro-2-n-propyldisilazane, 1,1,1,3,3-pentachloro-2-iso-propyldisilazane, 1,1,1,3,3-pentachloro-2-methyl-3-methyl-disilazane, 1,1,1,3,3-pentachloro-2-ethyl-3-methyldisilazane, 1,1,1,3,3-pentachloro-2-n-propyl-3-methyldisilazane, 1,1,1,3,3-pentachloro-2-iso-propyl-3-methyldisilazane, 1,1,1,3,3,3-hexabromo-2-methyldisilazane, 1,1,1,3,3,3-bromo-2-ethyldisilazane, 1,1,1,3,3,3-bromo-2-n-propyldisilazane, 1,1,1,3,3,3-bromo-2-iso-propyldisilazane, 1,1,1,3,3,3-bromo-2-n-butyldisilazane, 1,1,1,3,3,3-bromo-2-sec-butyldisilazane, 1,1,1,3,3,3-bromo-2-iso-butyldisilazane, 1,1,1,3,3,3-bromo-2-tert-butyldisilazane, 1,1,1,3,3,3-hexaiodo-2-

methyldisilazane, 1,1,1,3,3,3-iodo-2-ethyldisilazane, 1,1,1,3,3,3-iodo-2-n-propyldisilazane, 1,1,1,3,3,3-iodo-2-n-butyldisilazane, 1,1,1,3,3,3-iodo-2-iso-propyldisilazane, 1,1,1,3,3,3-iodo-2-iso-butyldisilazane, 1,1,1,3,3,3-iodo-2-sec-butyl-disilazane, 1,1,1,3,3,3-iodo-2-tert-butyl-disilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-methyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-tetrachloro-2-ethyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-n-propyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-iso-propyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-n-butyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-iso-butyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-sec-butyldisilazane, and 1,1,3,3-tetrachloro-1,3-dimethyl-2-tert-butyldisilazane, 1,1,3,3-tetrachloro-2-methyldisilazane , 1,1,3,3-tetrachloro-2-ethyldisilazane, 1,1,3,3-tetrachloro-2-n-propyldisilazane, 1,1,3,3-tetrachloro-2-iso-propyldisilazane, 1,1,3,3-tetrachloro-2-n-butyldisilazane, 1,1,3,3-tetrachloro-2-iso-butyldisilazane, 1,1,3,3-tetrachloro-2-sec-butyldisilazane, 1,1,3,3-tetrachloro-2-tert-butyldisilazane, 1,1,3,3-tetrabromo-2-methyldisilazane, 1,1,3,3-tetrabromo-2-ethyldisilazane, 1,1,3,3-tetrabromo-2-n-propyldisilazane, 1,1,3,3-tetrabromo-2-iso-propyldisilazane, 1,1,3,3-tetrabromo-2-n-butyldisilazane, 1,1,3,3-tetrabromo-2-iso-butyldisilazane, 1,1,3,3-tetrabromo-2-sec-butyldisilazane, 1,1,3,3-tetrabromo-2-tert-butyldisilazane, 1,1,3,3-tetraiodo-2-methyldisilazane, 1,1,3,3-tetraiodo-2-ethyldisilazane, 1,1,3,3-tetraiodo-2-n-propyldisilazane, 1,1,3,3-tetraiodo-2-iso-propyldisilazane, 1,1,3,3-tetraiodo-2-n-butyldisilazane, 1,1,3,3-tetraiodo-2-iso-butyldisilazane, 1,1,3,3-tetraiodo-2-sec-butyldisilazane, 1,1,3,3-tetraiodo-2-tert-butyldisilazane, 1,1,3,3-tetrachloro-2-cyclopentyldisilazane, 1,1,3,3-tetrachloro-2-cyclohexyldisilazane, 1,1,3,3-tetrachloro-1,3-dimethyl-2-cyclopentyldisilazane, and 1,1,3,3-tetrachloro-1,3-dimethyl-2-cyclohexyldisilazane;

purging the reactor with a purge gas;

providing a plasma source into the reactor to at least partially react with the at least one silazane precursor and deposit the silicon-containing film onto the one or more substrates; and

purging the reactor with a purge gas.

8. The method of claim 7 wherein the plasma source is selected from the group consisting of a plasma comprising hydrogen and argon, a plasma comprising hydrogen and helium plasma, an argon plasma, a helium plasma, and mixtures thereof.

5