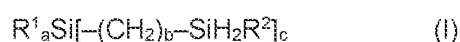


What is claimed is:

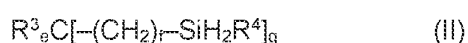
1. A reaction mixture for producing a film forming polycarbosilazane polymer or oligomer, the reaction mixture comprising carbosilanes and amines,
 wherein the carbosilanes contain at least two $-\text{SiH}_2-$ moieties, either as terminal groups ($-\text{SiH}_2\text{R}$) or embedded in a carbosilane cyclic compound, wherein R is H, a C_1 to C_6 linear, branched, or cyclic alkyl- group, a C_1 to C_6 linear, branched, or cyclic alkenyl- group, or combination thereof, and
 wherein the reaction mixture is capable of forming the film forming polycarbosilazane polymer or oligomer.

2. The reaction mixture of claim 1, wherein the film forming polycarbosilazane polymer or oligomer has a backbone that comprises $-\text{Si}-\text{N}-$ units, $-\text{Si}-\text{N}-\text{C}_n-\text{N}-\text{Si}-$ units, $-\text{Si}-\text{N}-\text{Si}-$ units or combinations thereof, wherein $n \geq 1$, wherein the backbone includes cross-linked $-\text{Si}-\text{N}-$ units, $-\text{Si}-\text{N}-\text{C}_n-\text{N}-\text{Si}-$ units, or $-\text{Si}-\text{N}-\text{Si}-$ units, branched $-\text{Si}-\text{N}-$ units, $-\text{Si}-\text{N}-\text{C}_n-\text{N}-\text{Si}-$ units, or $-\text{Si}-\text{N}-\text{Si}-$ units, or combinations thereof.

3. The reaction mixture of claim 1, wherein the carbosilane has the formula:



wherein R^1 , R^2 are independently H, a C_1 to C_6 linear, branched or cyclic alkyl- group, a C_1 to C_6 linear, branched or cyclic alkenyl- group, or combination thereof; $a = 0$ to 2 ; $b = 1$ to 4 ; $c = 4 - a$; or



wherein R^3 , R^4 are independently H, a C_1 to C_6 linear, branched or cyclic alkyl- group, a C_1 to C_6 linear, branched or cyclic alkenyl- group, or combination thereof; $e = 0$ to 2 ; $f = 0$ to 3 ; $g = 4 - e$; or



wherein R^5 is H, a C_1 to C_6 linear, branched, or cyclic alkyl- group, a C_1 to C_6 linear, branched or cyclic alkenyl- group, or combination thereof; $m = 0$ to 4 ; $n = 2$ to 4 ; and the scaffold is a hydrocarbon scaffold; or



wherein R^6 is a C_1 to C_6 linear, branched or cyclic alkyl- or alkenyl- group; $x = 0$ to 3 .

4. The reaction mixture of claim 3, wherein the hydrocarbon scaffold is a hydrocarbon scaffold including a C₃ to C₁₀ cyclic hydrocarbon scaffold containing silyl- group, -NH group, -O- ether group.
5. The reaction mixture of claim 1, wherein the carbosilane contains -Si-C_n-Si- unit (n ≥ 1) unit(s) or a 1,3,5-trisilacyclohexane (TSCH) backbone.
6. The reaction mixture of claim 1, wherein the carbosilane is selected from the group consisting of Si[-(CH₂)-SiH₃]₄, Si[-(CH₂)₂-SiH₃]₄, Si[-(CH₂)₃-SiH₃]₄, and Si[-(CH₂)₄-SiH₃]₄, R¹Si[-(CH₂)-SiH₃]₃, R¹Si[-(CH₂)₂-SiH₃]₃, R¹Si[-(CH₂)₃-SiH₃]₃, and R¹Si[-(CH₂)₄-SiH₃]₃, H₃Si-CH₂-SiH₂-CH₂-SiH₃ (bis(silylmethyl)silane), H₃Si-(CH₂)₂-SiH₂-(CH₂)₂-SiH₃ (bis(2-silylethyl)silane), H₃Si-(CH₂)₃-SiH₂-(CH₂)₃-SiH₃ (bis(3-silylpropyl)silane), and H₃Si-(CH₂)₄-SiH₂-(CH₂)₄-SiH₃ (bis(4-silylbutyl)silane), C[-SiH₃]₄ (tetrasilylmethane), C[-(CH₂)-SiH₃]₄ (2,2-bis(silylmethyl)propane-1,3-diyl)bis(silane)), C[-(CH₂)₂-SiH₃]₄ (3,3-bis(2-silylethyl)pentane-1,5-diyl)bis(silane)), and C[-(CH₂)₃-SiH₃]₄ (4,4-bis(3-silylpropyl)heptane-1,7-diyl)bis(silane)), R¹C[-SiH₃]₃, R¹C[-(CH₂)-SiH₃]₃, R¹C[-(CH₂)₂-SiH₃]₃, and R¹C[-(CH₂)₃-SiH₃]₃, H₃Si-CH₂-SiH₃ (bisilylmethane), H₃Si-(CH₂)₅-SiH₃ (1,5-disilylpentane)), and H₃Si-(CH₂)₇-SiH₃ (1,7-disilylheptane)), 1,3-disilylcyclopentane, 1,2-disilylcyclopentane, 1,4-disilylcyclohexane, 1,3-disilylcyclohexane, 1,2-disilylcyclohexane, 1,3,5-trisilylcyclohexane and 1,3,5-trisilylbenzene, 2-Me-TSCH, 2-Et-TSCH, 2-iPr-TSCH, 2-nPr-TSCH, 2-nBu-TSCH, 2-tBu-TSCH, 2-sBu-TSCH, 2-iBu-TSCH, 2,4-Me₂-TSCH, 2,4-Et₂-TSCH, 2,4-iPr₂-TSCH, 2,4-nPr₂-TSCH, 2,4-nBu₂-TSCH, 2,4-iBu₂-TSCH, 2,4-tBu₂-TSCH, 2,4-sBu₂-TSCH, 2,4,6-Me₃-TSCH, 2,4,6-Et₃-TSCH, 2,4,6-iPr₃-TSCH, 2,4,6-nPr₃-TSCH, 2,4,6-nBu₃-TSCH, 2,4,6-iBu₃-TSCH, 2,4,6-tBu₃-TSCH, 2,4,6-sBu₃-TSCH, and combinations thereof, wherein R¹ is H, a C₁-C₆ linear, branched, or cyclic alkyl- group, a C₁-C₆ linear, branched, or cyclic alkenyl- group, or combinations thereof.
7. The reaction mixture of claim 1, wherein the carbosilane is 1,3,5-trisilapentane (CAS No.: 5637-99-0) or 1,3,5-trisilacyclohexane (CAS No.: 291-27-0).
8. The reaction mixture of claim 1, wherein the amine is selected from one or more of ammonia, amidine, hydrazine, hydroxylamine, monoalkylamine, diamines including ethylene diamine, or polyamines, which polyamines contain at least two N-H bonds either on the same nitrogen atom or on separate nitrogen atoms.

9. The reaction mixture of claim 1, wherein the reaction mixture comprises a polysilane that contains more than two $-\text{SiH}_2\text{R}$ function groups, wherein R is H, a C_1 to C_6 linear, branched, or cyclic alkyl- group, a C_1 to C_6 linear, branched, or cyclic alkenyl- group, or a combination thereof.

10. The reaction mixture of any one of claims 1 to 9, wherein the polysilane is selected from one or more of neopentasilane ($\text{Si}(\text{SiH}_3)_4$), n-tetrasilane ($\text{SiH}_3(\text{SiH}_2)_2\text{SiH}_3$), 2-silyl-tetrasilane ($(\text{SiH}_3)_2(\text{SiH}_2)_2\text{SiH}_3$), trisilylamine ($\text{N}(\text{SiH}_3)_3$), or trisilylamine derivatives.

11. A method of forming a silicon and carbon containing film on a substrate, the method comprising the steps of:

producing a film forming polycarbosilazane polymer or oligomer by a polymerization of a reaction mixture of carbosilanes with amines;

forming a solution containing the film forming polycarbosilazane polymer or oligomer; and

contacting the solution with the substrate via a spin-on coating, spray coating, dip coating, or slit coating technique to form the silicon and carbon containing film,

wherein the carbosilanes contain at least two $-\text{SiH}_2-$ moieties, either as terminal groups ($-\text{SiH}_2\text{R}$) or embedded in a carbosilane cyclic compound, wherein R is H, a C_1 to C_6 linear, branched, or cyclic alkyl- group, a C_1 to C_6 linear, branched, or cyclic alkenyl- group, or a combination thereof.

12. The method of claim 11, further comprising the step of

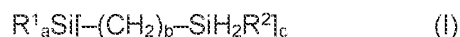
pre-baking the silicon and carbon containing film under N_2 atmosphere at a temperature ranging from approximately 50°C to 400°C ; and

subsequently hardbaking the silicon and carbon containing film by a heat-induced radical reaction or a UV-Vis photo induced radical reaction in an atmosphere of O_2 , O_3 , H_2O , H_2O_2 , N_2O , or NO , air, compressed air, or combinations thereof at a temperature range of 200 – 1000°C to convert the silicon and carbon containing film to a SiOC or SiOCN containing film.

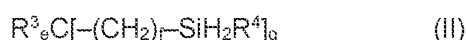
13. The method of claim 11, wherein the film forming polycarbosilazane polymer or oligomer has a backbone that comprises $-\text{Si}-\text{N}-$ units, $-\text{Si}-\text{N}-\text{C}_n-\text{N}-\text{Si}-$ units, $-\text{Si}-\text{N}-\text{Si}-$ units or combinations thereof, wherein $n \geq 1$, wherein the backbone includes cross-linked –

Si–N– units, –Si–N–C_n–N–Si– units or –Si–N–Si– units, branched –Si–N– units, –Si–N–C_n–N–Si– units or –Si–N–Si– units, or combinations thereof.

14. The method of claim 11, wherein the carbosilane has the formula:



wherein R¹, R² are independently H, a C₁ to C₆ linear, branched or cyclic alkyl– group, a C₁ to C₆ linear, branched or cyclic alkenyl– group, or combination thereof; a = 0 to 2; b = 1 to 4; c = 4 – a; or



wherein R³, R⁴ are independently H, a C₁ to C₆ linear, branched or cyclic alkyl– group, a C₁ to C₆ linear, branched or cyclic alkenyl– group, or combination thereof; e = 0 to 2; f = 0 to 3; g = 4 – e; or



wherein R⁵ is H, a C₁ to C₆ linear, branched, or cyclic alkyl– group, a C₁ to C₆ linear, branched or cyclic alkenyl– group, or combination thereof; m = 0 to 4; n = 2 to 4; and the scaffold is a hydrocarbon scaffold; or



wherein R⁶ is a C₁ to C₆ linear, branched or cyclic alkyl– or alkenyl– group; x = 0 to 3.

15. The method of claim 11, wherein the carbosilane is selected from the group consisting of Si[-(CH₂)-SiH₃]₄, Si[-(CH₂)₂-SiH₃]₄, Si[-(CH₂)₃-SiH₃]₄, Si[-(CH₂)₄-SiH₃]₄, R¹Si[-(CH₂)-SiH₃]₃, R¹Si[-(CH₂)₂-SiH₃]₃, R¹Si[-(CH₂)₃-SiH₃]₃, R¹Si[-(CH₂)₄-SiH₃]₃, H₃Si-CH₂-SiH₂-CH₂-SiH₃ (bis(silylmethyl)silane), H₃Si-(CH₂)₂-SiH₂-(CH₂)₂-SiH₃ (bis(2-silylethyl)silane), H₃Si-(CH₂)₃-SiH₂-(CH₂)₃-SiH₃ (bis(3-silylpropyl)silane), and H₃Si-(CH₂)₄-SiH₂-(CH₂)₄-SiH₃ (bis(4-silylbutyl)silane), C[-SiH₃]₄ (tetrasilylmethane), C[-(CH₂)-SiH₃]₄ (2,2-bis(silylmethyl)propane-1,3-diylbis(silane)), C[-(CH₂)₂-SiH₃]₄ (3,3-bis(2-silylethyl)pentane-1,5-diylbis(silane)), and C[-(CH₂)₃-SiH₃]₄ (4,4-bis(3-silylpropyl)heptane-1,7-diylbis(silane)), R¹C[-SiH₃]₃, R¹C[-(CH₂)-SiH₃]₃, R¹C[-(CH₂)₂-SiH₃]₃, and R¹C[-(CH₂)₃-SiH₃]₃, H₃Si-CH₂-SiH₃ (bisilylmethane), H₃Si-(CH₂)₅-SiH₃ (1,5-disilylpentane), and H₃Si-(CH₂)₇-SiH₃ (1,7-disilylheptane), 1,3-disilylcyclopentane, 1,2-disilylcyclopentane, 1,4-disilylcyclohexane, 1,3-disilylcyclohexane, 1,2-disilylcyclohexane, 1,3,5-trisilylcyclohexane and 1,3,5-trisilylbenzene, 2-Me-TSCH, 2-Et-TSCH, 2-iPr-TSCH, 2-nPr-TSCH, 2-nBu-TSCH, 2-tBu-TSCH, 2-sBu-TSCH, 2-iBu-TSCH, 2,4-Me₂-TSCH, 2,4-Et₂-TSCH, 2,4-iPr₂-TSCH, 2,4-nPr₂-TSCH, 2,4-nBu₂-TSCH, 2,4-iBu₂-

TSCH, 2,4-*t*Bu₂-TSCH, 2,4-*s*Bu₂-TSCH, 2,4,6-Me₃-TSCH, 2,4,6-Et₃-TSCH, 2,4,6-*i*Pr₃-TSCH, 2,4,6-*n*Pr₃-TSCH, 2,4,6-*n*Bu₃-TSCH, 2,4,6-*i*Bu₃-TSCH, 2,4,6-*t*Bu₃-TSCH, 2,4,6-*s*Bu₃-TSCH, and combinations thereof; and wherein R¹ is H, a C₁-C₆ linear, branched, or cyclic alkyl- group, a C₁-C₆ linear, branched, or cyclic alkenyl- group, or a combination thereof.

16. The method of claim 11, wherein the carbosilane is 1,3,5-trisilapentane (CAS No.: 5637-99-0) or 1,3,5-trisilacyclohexane (CAS No.: 291-27-0).

17. The method of 11, wherein the step of the producing the film forming polycarbosilazane polymer or oligomer comprises the step of adding a catalyst to the reaction mixture, wherein the film forming polycarbosilazane polymer or oligomer is produced by a polymerization of the reaction mixture through a catalytic dehydrocoupling (DHC) reaction.

18. The method of claim 17, wherein the catalyst is NH₄Cl.

19. The method of 11, wherein the step of the producing the film forming polycarbosilazane polymer or oligomer comprises the step of adding a polysilane that contains more than two -SiH₂R function groups to the reaction mixture for enhancing the polymerization of the carbosilanes with amines, wherein R is H, a C₁ to C₆ linear, branched, or cyclic alkyl- group, a C₁ to C₆ linear, branched, or cyclic alkenyl- group, or a combination thereof.

20. The method of 19, wherein the polysilane is selected from one or more of neopentasilane (or 2,2-disilyltrisilane) (Si(SiH₃)₄), *n*-tetrasilane (SiH₃(SiH₂)₂SiH₃), 2-silyl-tetrasilane ((SiH₃)₂(SiH₂)₂SiH₃), trisilylamine (N(SiH₃)₃), or trisilylamine derivatives such as alkylamino-substituted trisilylamines or oligomers of trisilylamines.

21. The method of any one of claims 11 to 20, wherein the film forming polycarbosilazane polymer or oligomer is produced by the polymerization of the carbosilanes with amines through the catalytic dehydrocoupling (DHC) reaction selected from one or more of

- i) two carbosilanes with two amines, wherein one of the two carbosilanes contains the at least two $\text{--SiH}_2\text{--}$ moieties, either as the terminal groups ($\text{--SiH}_2\text{R}$) or embedded in the carbosilane cyclic compound;
- ii) two carbosilanes with two amines, wherein one of the two amines contains more than two N–H bonds; and
- iii) more than two carbosilanes with more than two amines,

wherein R is H, a C_1 to C_6 linear, branched, or cyclic alkyl– group, a C_1 to C_6 linear, branched, or cyclic alkenyl– group, or a combination thereof.

22. A silicon and carbon containing film forming composition comprising:

a film forming polycarbosilazane polymer or oligomer that has a backbone comprising --Si--N-- units, $\text{--Si--N--C}_n\text{--N--Si--}$ units, --Si--N--Si-- units or combinations thereof, wherein $n \geq 1$,

wherein the backbone includes cross-linked --Si--N-- units, $\text{--Si--N--C}_n\text{--N--Si--}$ units or --Si--N--Si-- units, branched --Si--N-- units, $\text{--Si--N--C}_n\text{--N--Si--}$ units or --Si--N--Si-- units, or combinations thereof.