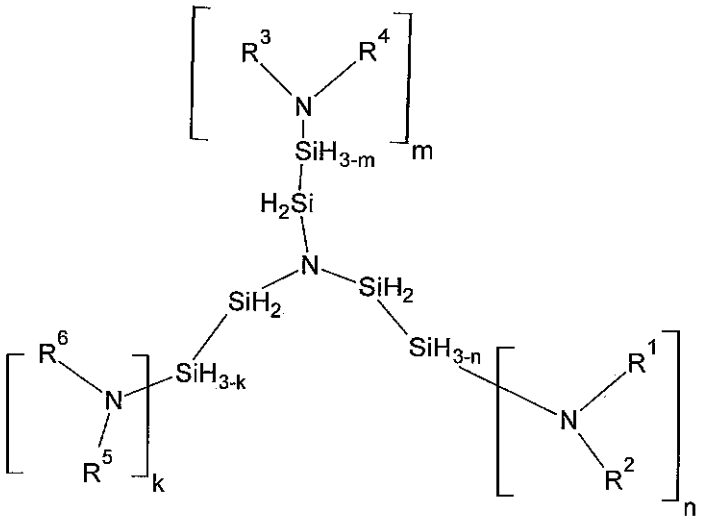
where n = 1 to 3; m = 0 to 3; k = 0 to 3; R^1, R^3, and R^5 are independently selected from the group of H, linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, silyl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^2, R^4, and R^6 are independently selected from the group of linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^1R^2N, R^3R^4N and R^5R^6N can be saturated or unsaturated cyclic secondary amines independently selected from the group aziridine, azetidine, piperidine, pyrrolidine, pyrrole, imidazole, pyrazole, indole or any C-substituted derivatives of the cyclic secondary amine; and excluding compounds having the formula $C_{18}H_{48}N_4Si_3$; $C_{15}H_{41}N_3Si_3$; $C_6H_{21}NSi_3$ and $C_7H_{23}NSi_3$ or $[(SiH_3)_2N]_2SiH_2$.

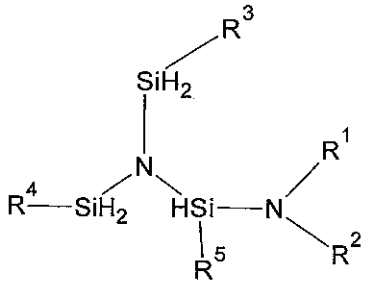
In another aspect, there is provided a compound having the formula:



where n = 1 to 3; m = 0 to 3; k = 0 to 3; R^1, R^3, and R^5 are independently selected from the group of H, linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, silyl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-

substituted silyl; R^2, R^4, and R^6 are independently selected from the group of linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, silyl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^1R^2N, R^3R^4N and R^5R^6N can be saturated or unsaturated cyclic secondary amines independently selected from the group aziridine, azetidine, piperidine, pyrrolidine, pyrrole, imidazole, pyrazole, indole or any C-substituted derivatives of the cyclic secondary amine.

In another aspect, there is provided a compound having the formula:



where R^1, R^2 are independently selected from the group of H, linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^3, R^4, and R^5 are independently selected from H and the group of linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, linear or branched C_1 to C_6 alkyl ether, silyl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; and R^1R^2N can be a saturated or unsaturated cyclic secondary amine selected from the group of aziridine, azetidine, piperidine, pyrrolidine, pyrrole, imidazole, pyrazole, indole or any C-substituted derivatives of the cyclic secondary amine.

In another aspect, there is provided a method of preparing the compounds described herein, comprising:

a) contacting the reactants TSA and n R^1R^2NH and m R^3R^4NH and k R^5R^6NH in the presence of a transition metal catalyst forming a reaction mixture;

b) optionally adding a solvent to the reaction mixture;

c) maintaining the reaction mixture at a temperature between about 0 °C to about 250 °C;

d) allowing the reaction to proceed to form $(R^1R^2N)_n(R^3R^4N)_m$ $(R^5R^6N)_k$ $(NSi_3H_{(9-n-m-k)})$ + (n+m+k) H_2 ;

e) separating the $(R^1R^2N)_n(R^3R^4N)_m$ $(R^5R^6N)_k$ $(NSi_3H_{(9-n-m-k)})$ from the reaction mixture;

wherein the reaction mixture temperature may vary during the synthesis and is maintained such that the temperature of the reaction mixture is not allowed to drop below about 0°C and not exceed about 250 °C.

In another aspect, there is provided a method of depositing a Si containing thin film by a vapor deposition wherein the precursor compound is selected from the group of compounds described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a typical reactor apparatus wherein the reaction vessel is an autoclave reactor fitted with a stirrer and connected to a manifold capable of providing vacuum and reactants.

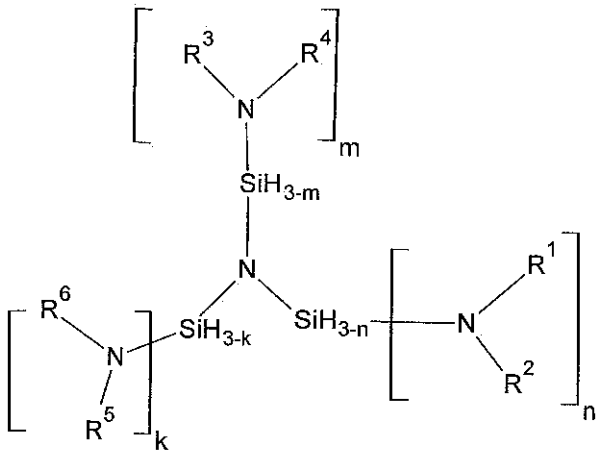
Figure 2 is a typical reactor apparatus wherein the reactor vessel is attached to a condenser allowing for hydrogen venting and a Dip-tube with filter for removal of the product.

DETAILED DESCRIPTION OF THE INVENTION

[0005] A method for the synthesis of compounds having silicon-nitrogen bonds without the formation of halogen salt byproducts has been developed. All of the compounds produced by

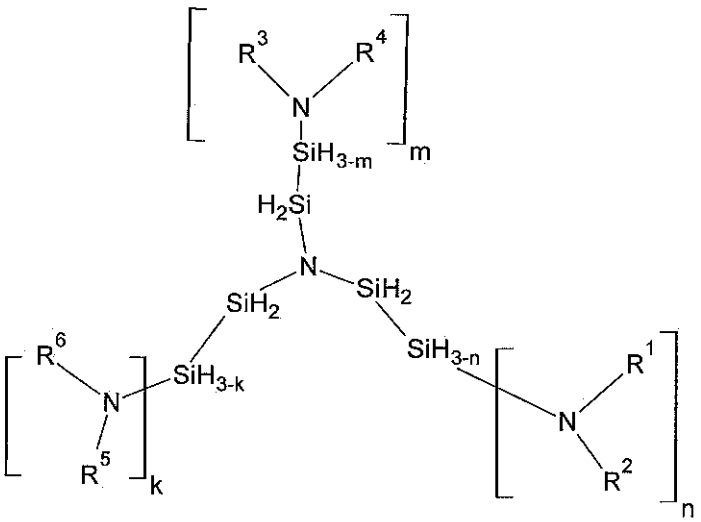
We Claim:

1. A compound having the formula;



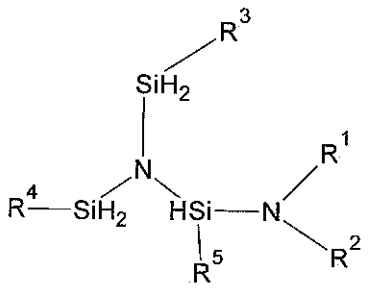
where n = 1 to 3; m = 0 to 3; k = 0 to 3; R^1, R^3, and R^5 are independently selected from the group of H, linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, silyl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^2, R^4, and R^6 are independently selected from the group of linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^1R^2N, R^3R^4N and R^5R^6N can be saturated or unsaturated cyclic secondary amines independently selected from the group aziridine, azetidine, piperidine, pyrrolidine, pyrrole, imidazole, pyrazole, indole or any C-substituted derivatives of the cyclic secondary amine; and excluding compounds having the formula $C_{18}H_{48}N_4Si_3$; $C_{15}H_{41}N_3Si_3$; $C_6H_{21}NSi_3$ and $C_7H_{23}NSi_3$ or $[(SiH_3)_2N]_2SiH_2$.

2. A compound having the formula:



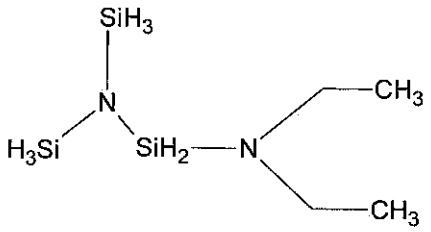
where n = 1 to 3; m = 0 to 3; k = 0 to 3; R^1, R^3, and R^5 are independently selected from the group of H, linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, silyl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^2, R^4, and R^6 are independently selected from the group of linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, silyl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^1R^2N, R^3R^4N and R^5R^6N can be saturated or unsaturated cyclic secondary amines independently selected from the group aziridine, azetidine, piperidine, pyrrolidine, pyrrole, imidazole, pyrazole, indole or any C-substituted derivatives of the cyclic secondary amine.

3. A compound having the formula:



where R^1, R^2 are independently selected from the group of H, linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; R^3, R^4, and R^5 are independently selected from H and the group of linear or branched C_1 to C_6 alkyl, linear or branched C_1 to C_8 alkenyl, linear or branched C_1 to C_8 alkynyl, C_6 to C_{10} aryl, linear or branched C_1 to C_6 alkyl ether, silyl, trimethyl silyl, or linear or branched C_1 to C_6 alkyl-substituted silyl; and R^1R^2N can be a saturated or unsaturated cyclic secondary amine selected from the group of aziridine, azetidine, piperidine, pyrrolidine, pyrrole, imidazole, pyrazole, indole or any C-substituted derivatives of the cyclic secondary amine.

4. The compound of claim 3 having the formula:



5. The compound of claim 3 wherein R^1, R^2 are independently selected from the group consisting of H, methyl, ethyl, iso-propyl, and t-butyl; and NR^1R^2 are a saturated or unsaturated cyclic amine with 3 to 8 carbon atoms selected from the group of azetidine, piperidine, pyrrolidine, pyrrole, imidazole, pyrazole, indole or any C-substituted derivatives of the cyclic secondary amine, when R^1 is H then R^2 cannot be methyl or ethyl.

6. The compound of claim 3 wherein R^1, R^2 are iso-propyl.

7. The compound of claim 3 wherein R^1, R^2 are ethyl.

8. A method of preparing the compounds according to claim 1, comprising:

a) contacting the reactants TSA and n R^1R^2NH and m R^3R^4NH and k R^5R^6NH in the presence of a transition metal catalyst forming a reaction mixture;

b) optionally adding a solvent to the reaction mixture;

c) maintaining the reaction mixture at a temperature between about 0 °C to about 250 °C;

d) allowing the reaction to proceed to form $(R^1R^2N)_n(R^3R^4N)_m$ $(R^5R^6N)_k$ $(NSi_3H_{(9-n-m-k)})$ + $(n+m+k)$ H_2 ;

e) separating the $(R^1R^2N)_n(R^3R^4N)_m$ $(R^5R^6N)_k$ $(NSi_3H_{(9-n-m-k)})$ from the reaction mixture;

wherein the reaction mixture temperature may vary during the synthesis and is maintained such that the temperature of the reaction mixture is not allowed to drop below about 0°C and not exceed about 250 °C.

9. The method of claim 8 wherein the transition metal catalyst is selected from the group consisting of Ru, Pd, Rh, Ir, Fe, Ni, Pt, Cr, Cu and Au.

10. A method of preparing the compounds according to claim 3, comprising:

a) contacting the reactants $N[(SiH_2R^3)(SiH_2R^4)(SiH_2R^5)]$ and HNR^1R^2 in the presence of a transition metal catalyst forming a reaction mixture;

b) optionally adding a solvent to the reaction mixture;

c) maintaining the reaction mixture at a temperature between about 0 °C to about 250 °C;

d) allowing the reaction to proceed to form $N[(SiH_2R^3)(SiH_2R^4)(SiHR^5\ NR^1R^2)]$;

e) separating the product $N[(SiH_2R^3)(SiH_2R^4)(SiHR^5\ NR^1R^2)]$ from the reaction mixture;

wherein the reaction mixture temperature may vary during the synthesis and is maintained such that the temperature of the reaction mixture is not allowed to drop below about 0°C and not exceed about 250 °C.