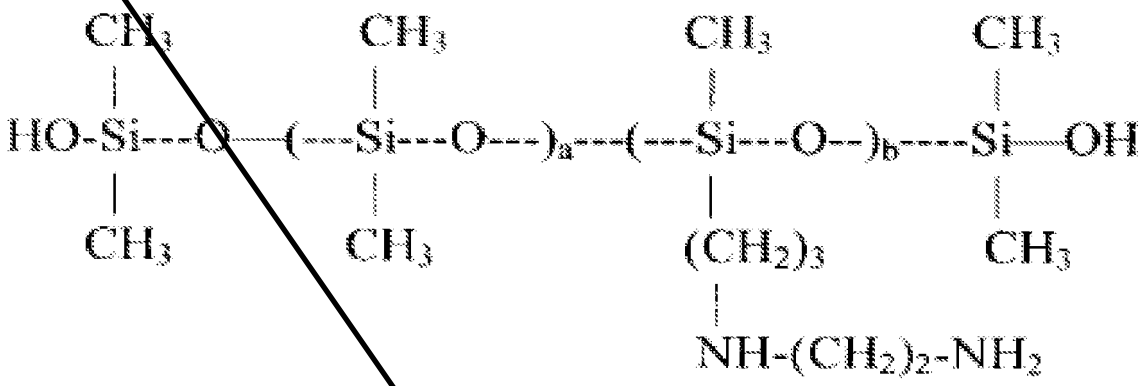
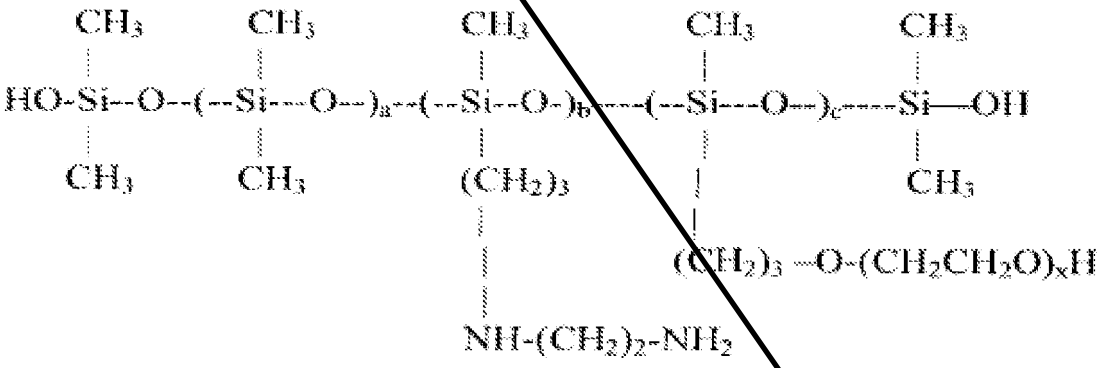
WHAT IS CLAIMED IS:

1. A method for preparing a polyamide composite membrane, the method comprising: reacting an aqueous phase, an organic phase and an additive, wherein the aqueous phase comprises an amine, the organic phase comprises a polyacyl halide and the additive is a compound selected from the group consisting of:



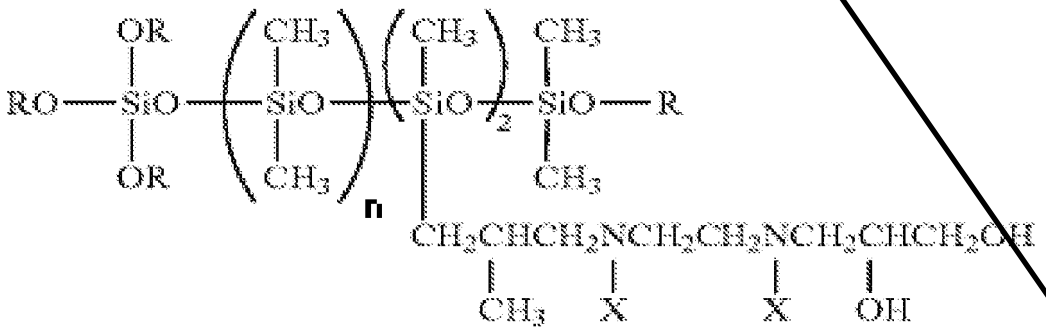
,

wherein a and b are integers between 1 and 100 and the sum of a + b is not greater than 100;

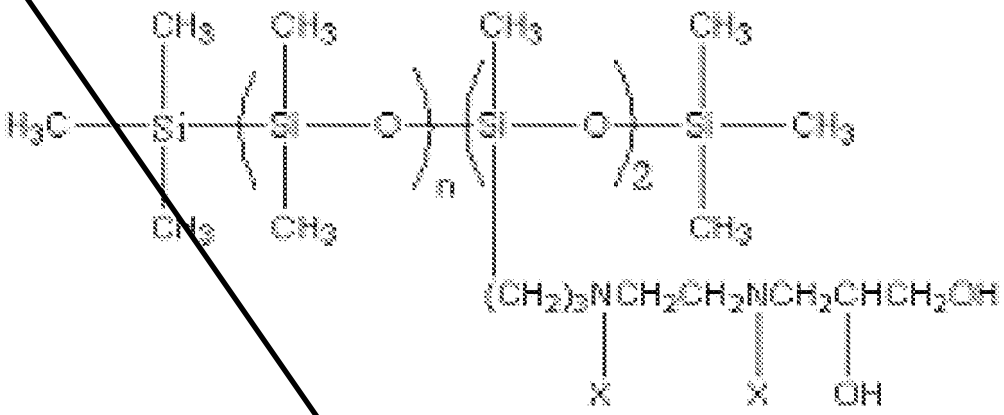


,

wherein a, b and c are integers between 1 and 100, the sum of a+b+c is not greater than 100 and x is an integer between 1 and 50;

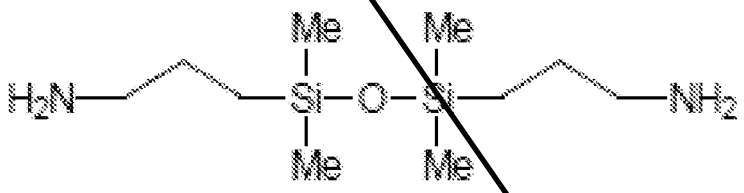


wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of $-CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and 100;

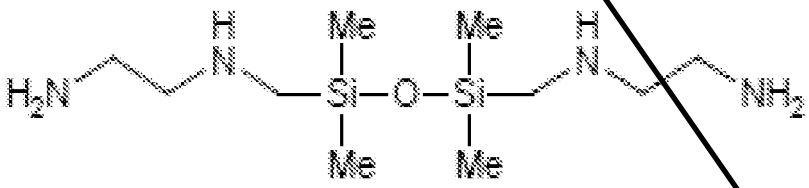


,

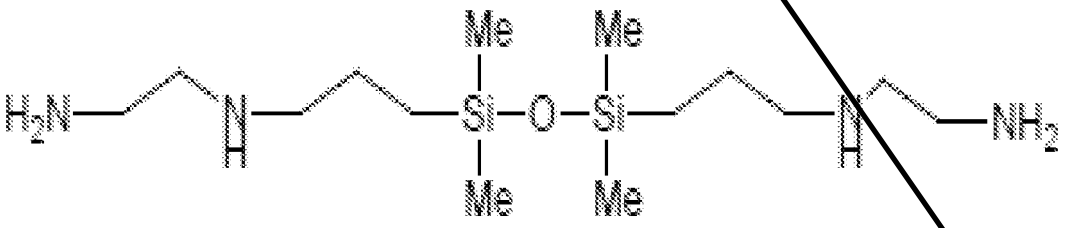
wherein x is either $-CH_2CH(OH)CH_2OH$ or H; and n is an integer between 4 and 100;



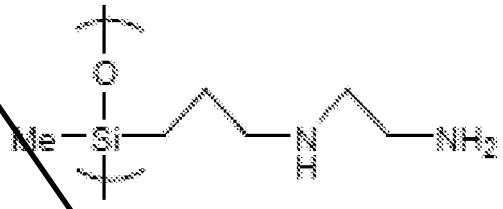
,



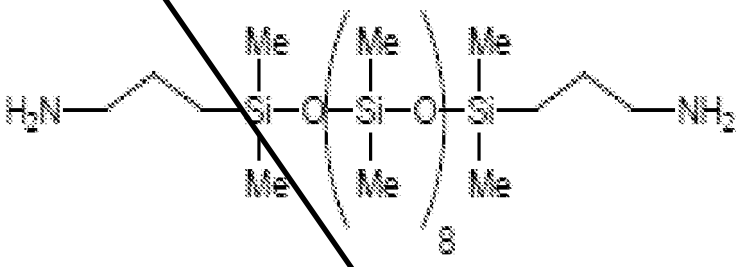
,



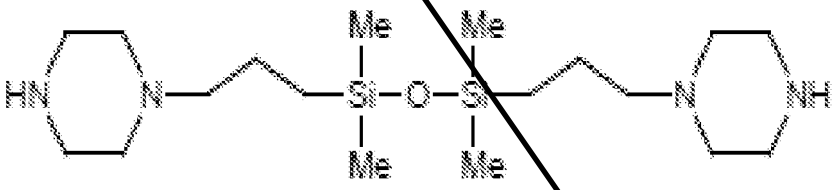
,



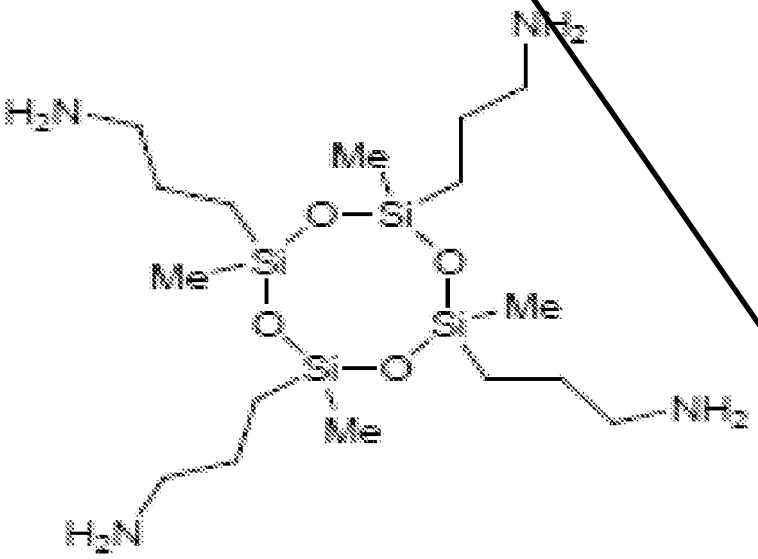
,



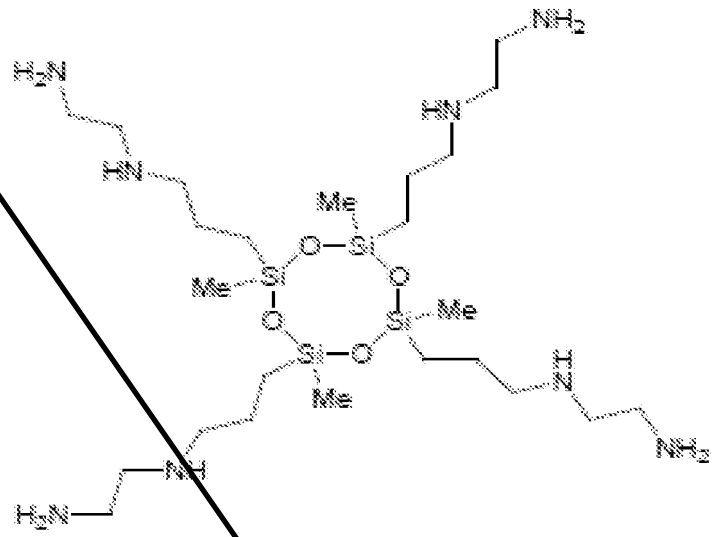
,



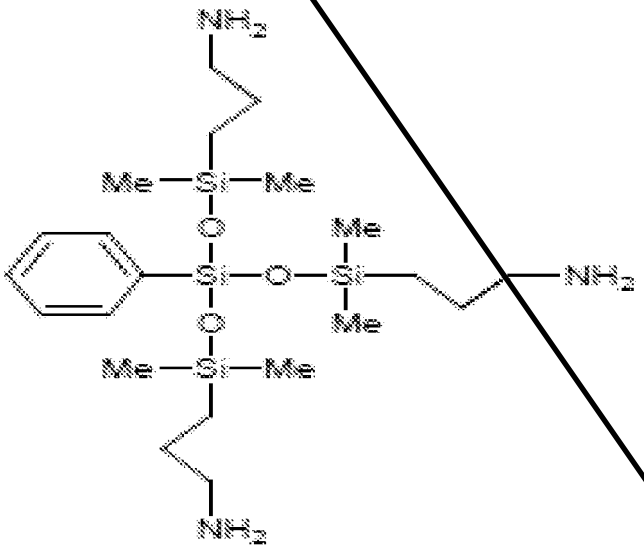
,



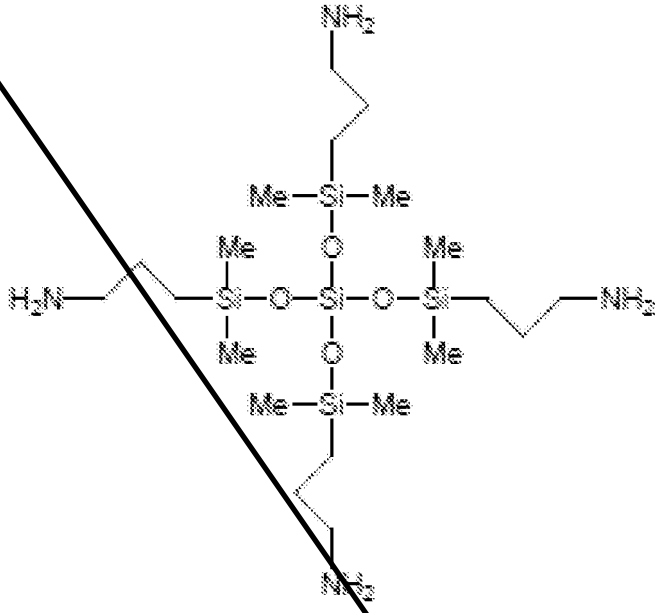
,



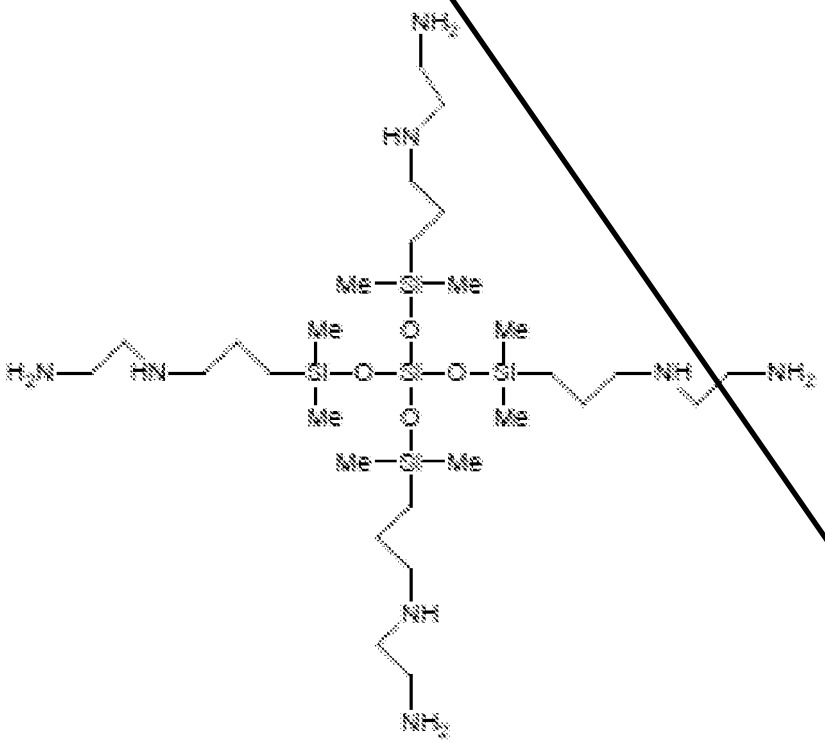
,



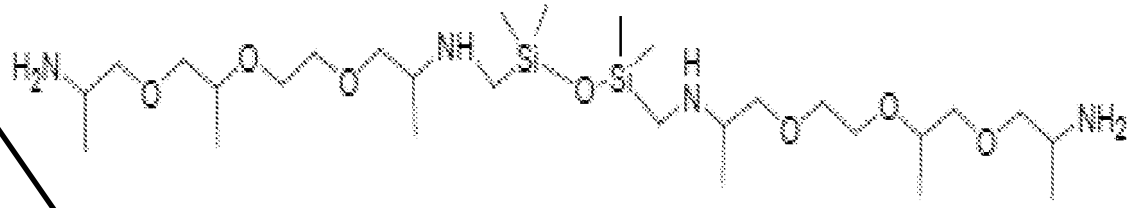
,



,

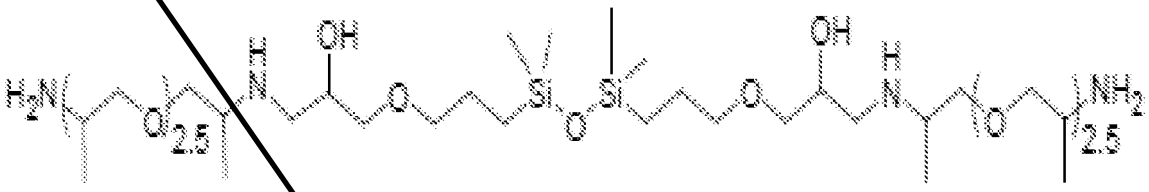


,



,

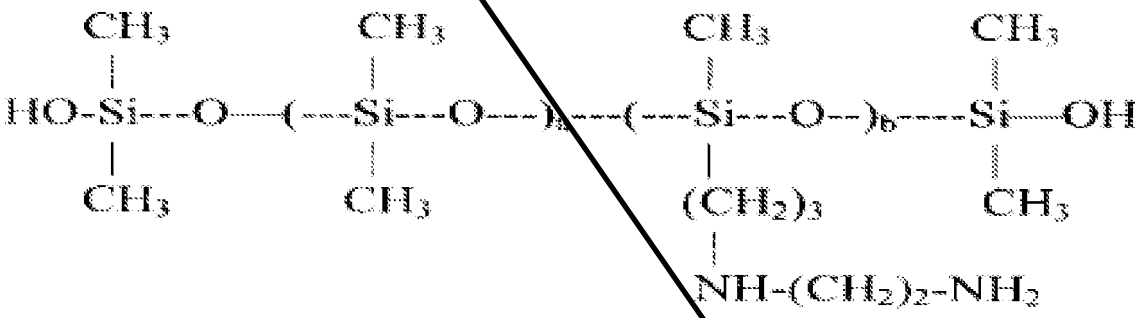
and



;

wherein the reaction occurs at or near the surface of a substrate.

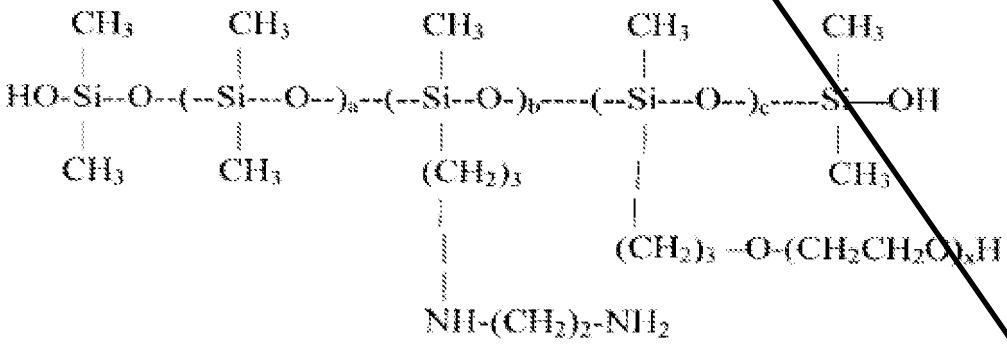
2. The method of claim 1, wherein the additive is a compound of the formula:



,

wherein a and b are integers between 1 and 100 and the sum of a + b is less than about 100.

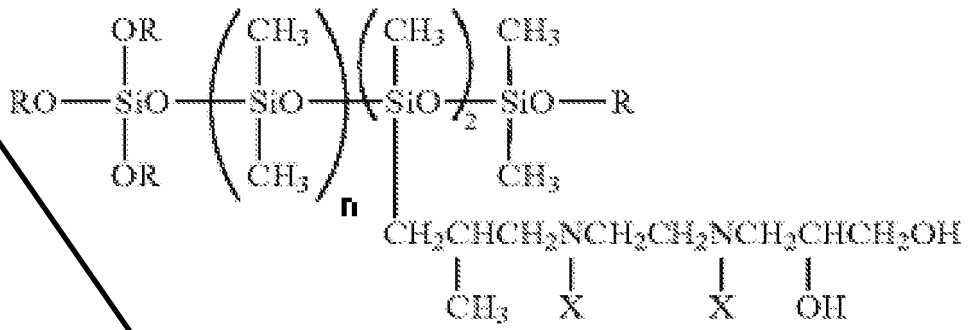
2. The method of claim 1, wherein the additive is a compound of the formula:



,

wherein a, b and c are integers between 1 and 100, the sum of a+b+c is less than about 100; and x is an integer between 1 and 50.

4. The method of claim 1, wherein the additive is a compound of the formula:



wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of $-CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and about 100.

5. The method of claim 1, wherein the amine is selected from the group consisting of: cyclic polyfunctional amines; acyclic polyfunctional amines; substituted cyclic polyfunctional amines; aromatic polyfunctional amines; substituted aromatic polyfunctional amines; multi-aromatic ring polyfunctional amines; substituted multi-aromatic ring polyfunctional amines; and combinations thereof.

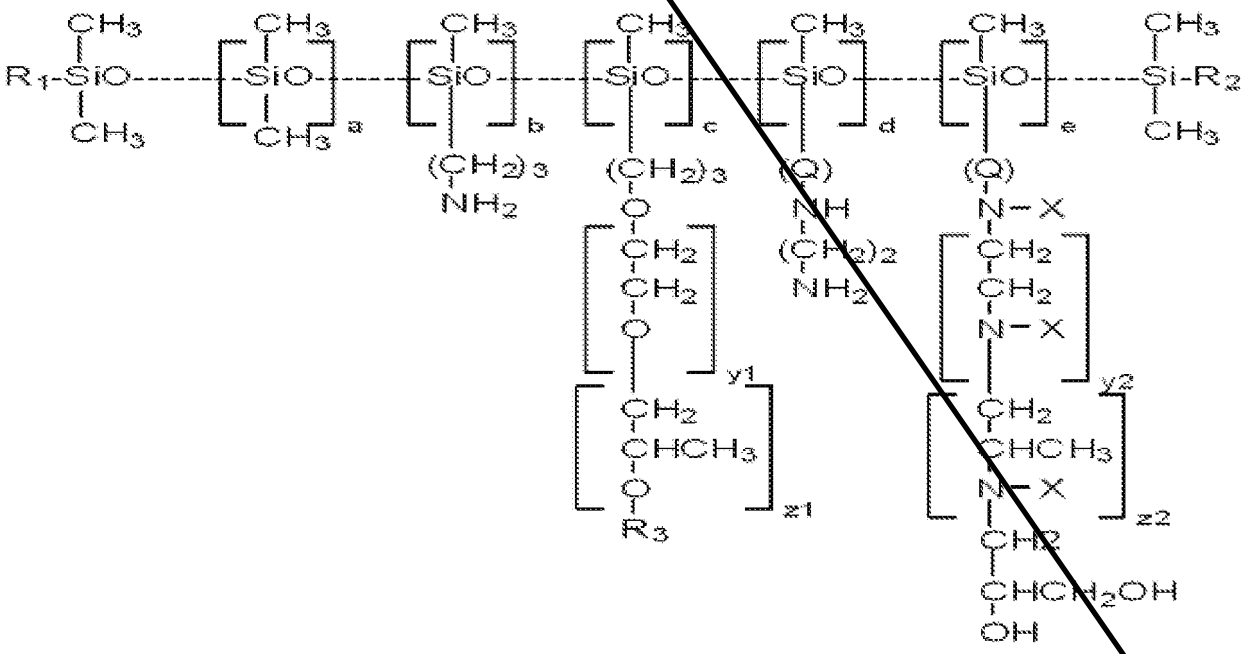
6. The method of claim 1, wherein the amine is selected from the group consisting of: piperazine; 1,2-ethanediamaine; methyl piperazine; dimethyl piperazine; m-phenylenediamine; o-phenylenediamine; p-phenylenediamine; chlorophenylenediamine; N,N^1-dimethyl-1,3-phenylenediamine; benzidine; $3,3^1$-dimethylbenzidene, $3,3^1$-dichlorobenzidine, and combinations thereof.

7. The method of claim 1, wherein the organic phase comprises a compound selected from the group consisting of: di-carboxylic acid halides; tri-carboxylic acid halides; di-tri carboxylic acid halides; tri-tri carboxylic acid halides; isomeric phthaloyl halides; aromatic di-sulfonyl halides; tri-sulfonyl halides; aromatic di-isocyanates; aromatic tri-isocyanates, aromatic di-chloroformates; aromatic tri-chloroformates, aromatic rings substituted with mixtures of the above and combinations thereof.

8. The method of claim 1, wherein the organic phase comprises a compound selected from the group consisting of: trimesoyl chloride (1,3,5-benzene tricarboxylic acid chloride), isophthaloyl chloride, terephthaloyl chloride, 1,3,5-cyclohexanetricarbonyl chloride, 1,2,3,4-cyclopentanetetracarbonyl chloride, trimesoyl bromide (1,3,5-benzene tricarboxylic acid bromide), isophthaloyl bromide, terephthaloyl bromide, trimesoyl iodine (1,3,5-benzene tricarboxylic acid iodide), isophthaloyl iodide, terephthaloyl iodide and combinations thereof.

9. The method of claim 1, wherein the substrate is selected from the group consisting of: fibrous and nanofibrous webs; sintered metals; sintered ceramics; polysulfones; polycarbonates; micro-porous polyolefins; polyamides; polyimides; polynitriles; polyimines; polyphenylene ethers; polyketones; polyetherketones; halogenated polymers; polyvinylidine fluoride and combinations thereof.

10. A method for preparing a polyamide composite membrane, the method comprising: reacting an aqueous phase, an organic phase and an additive, wherein the aqueous phase comprises an amine, the organic phase comprises a polyacyl halide and the additive is a compound of the formula:



wherein R1 and R2 may be the same or different, and are C1-C20 alkyl or alkoxy groups; R3 may be a C1-C4 alkyl group, or H; Q is either $-(CH_2)^3-$ or $-CH_2CH(CH_3)CH_2-$; X is either $-CH_2CH(OH)CH_2OH$ or H; a, b, c, d, e are integers such that the sum of a+b+c+d+e is less than 100, if b is 0, then d or e must be greater than 0, if d is 0, then b or e must be greater than 0; and if e is 0, then b or d must be greater than 0; and, y1, y2, z1, z2 are each integers between 0 to 10;

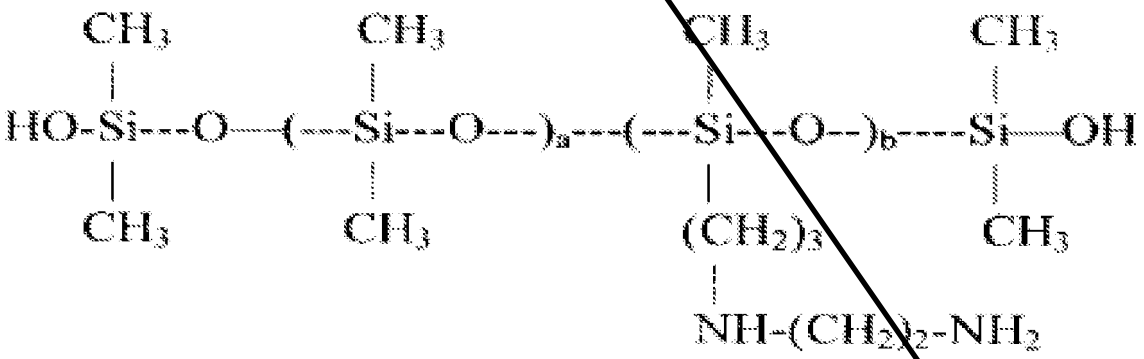
wherein the reaction occurs at or near the surface of a substrate.

11. Use of a polyamide composite membrane prepared by the method of claim 1 in a reverse osmosis process or a nanofiltration process.

12. A composite membrane for reverse osmosis or nanofiltration, the membrane comprising:

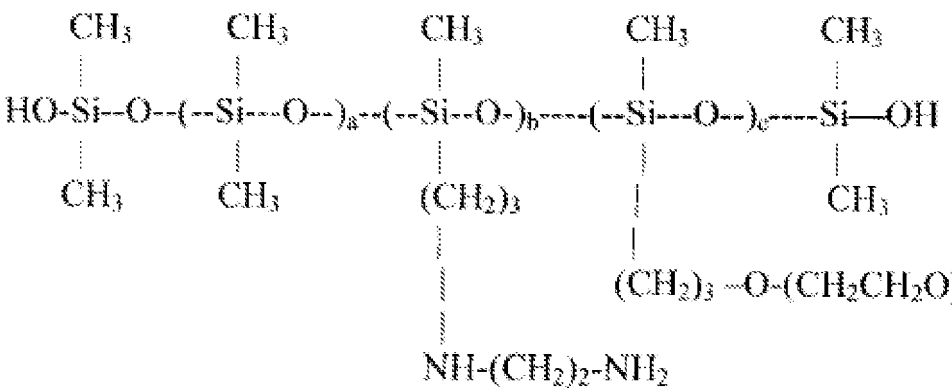
a porous substrate;

a polymer layer on a surface of the porous substrate, wherein the polymer layer comprises a polyamide that is a reaction product of an aqueous phase, an organic phase and an additive, wherein the aqueous phase comprises an amine, the organic phase comprises a polyacyl halide, and the additive is selected from the group consisting of:



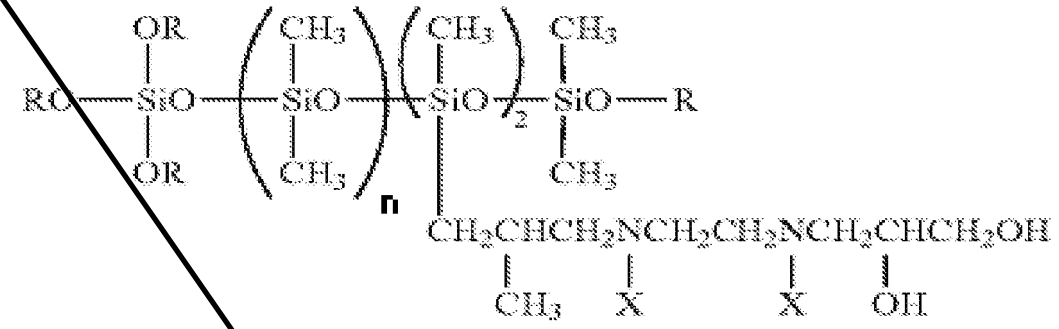
,

wherein a and b are integers between 1 and 100 and the sum of a + b is not greater than 100;

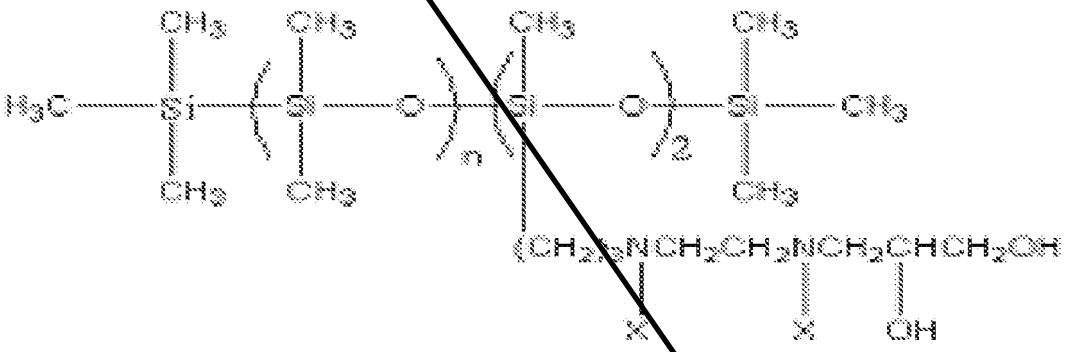


,

wherein a, b and c are integers between 1 and 100, the sum of a+b+c is not greater than 100 and x is an integer between 1 and 50;

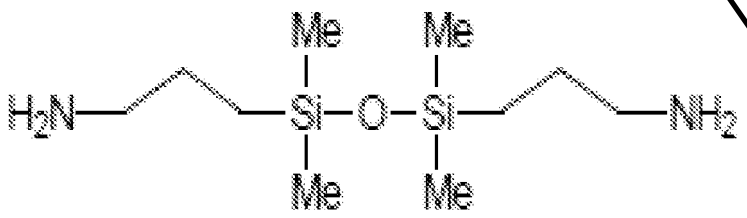


wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of $-CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and 100;

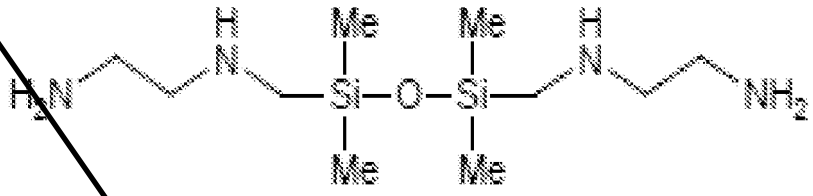


,

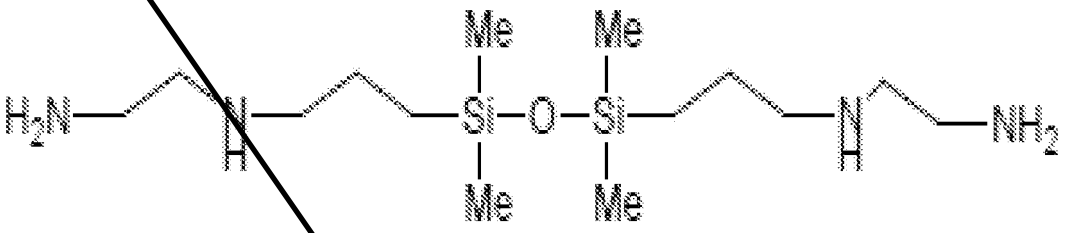
wherein x is either $-CH_2CH(OH)CH_2OH$ or H; and n is an integer between 4 and 100;



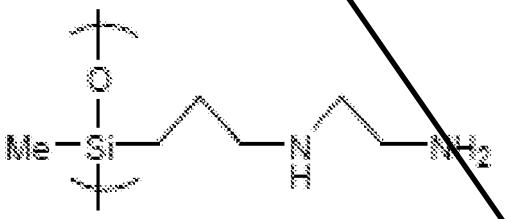
,



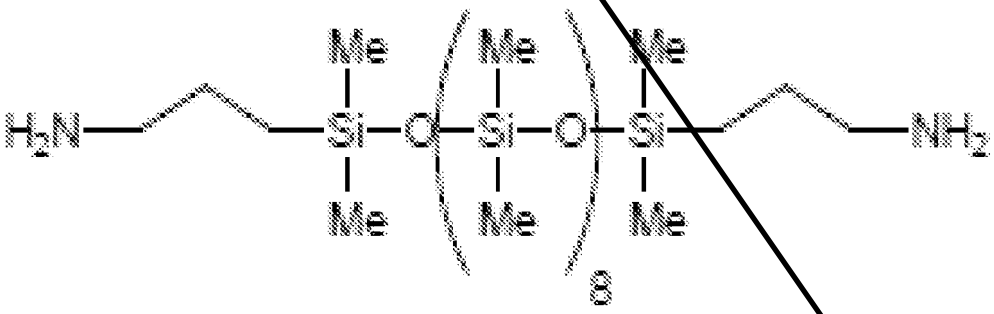
,



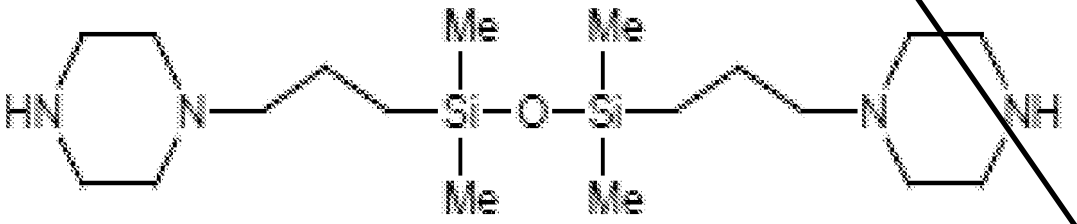
,



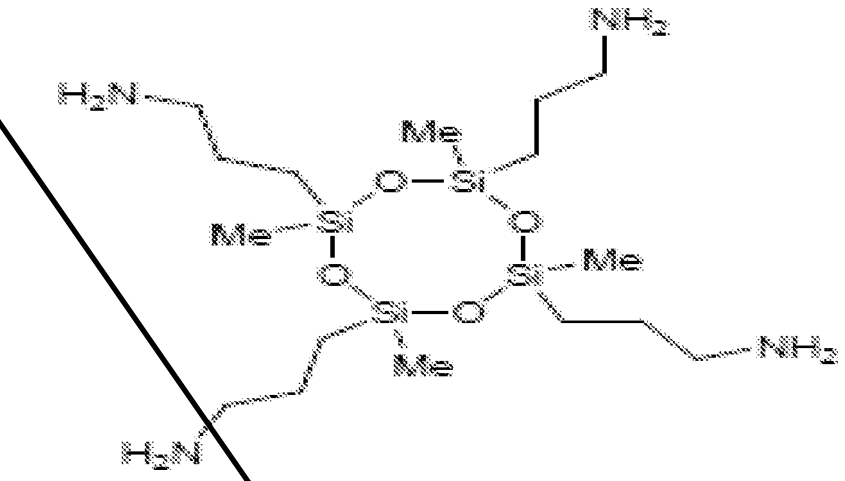
,



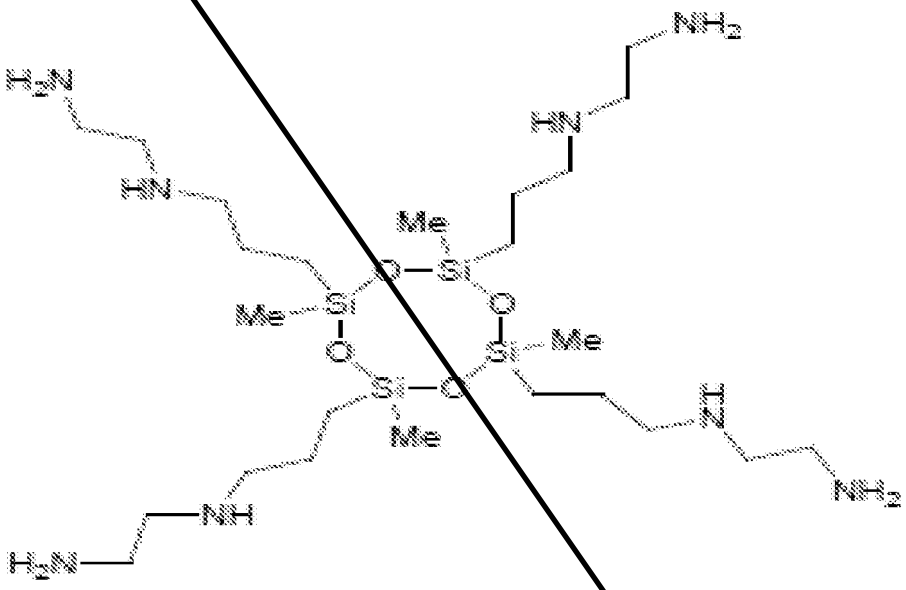
,



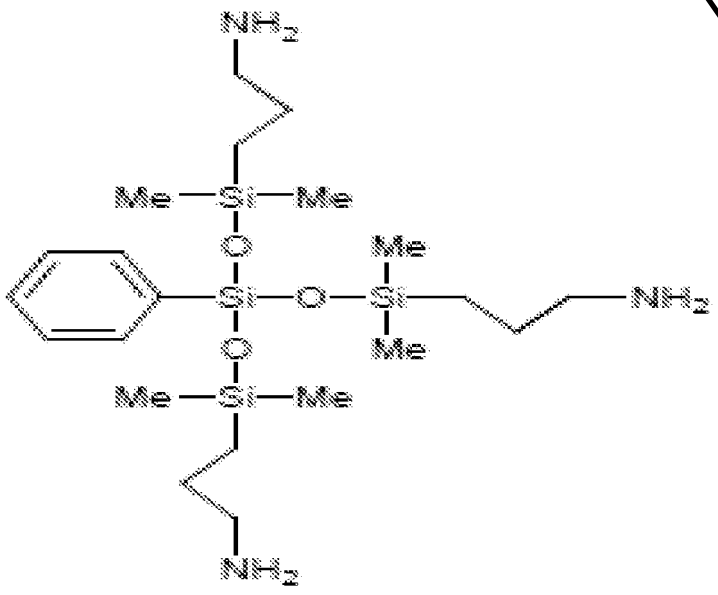
,



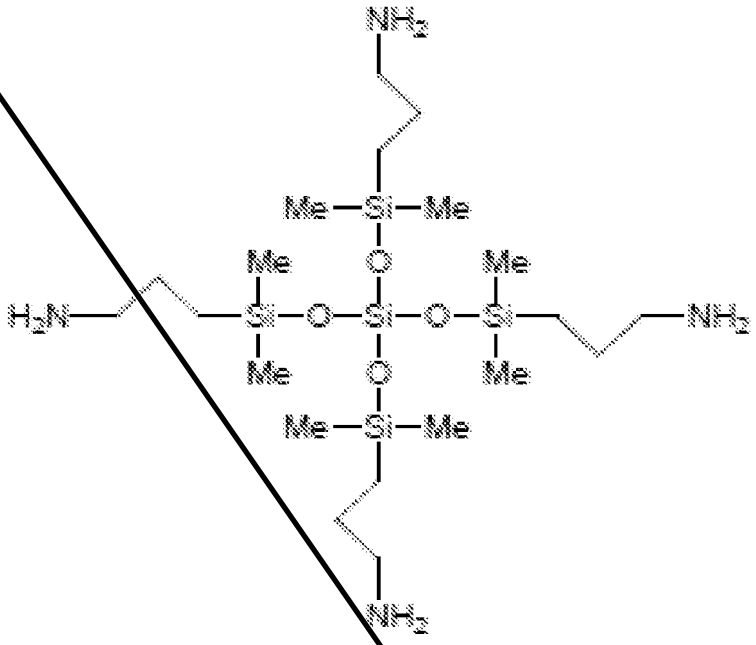
,



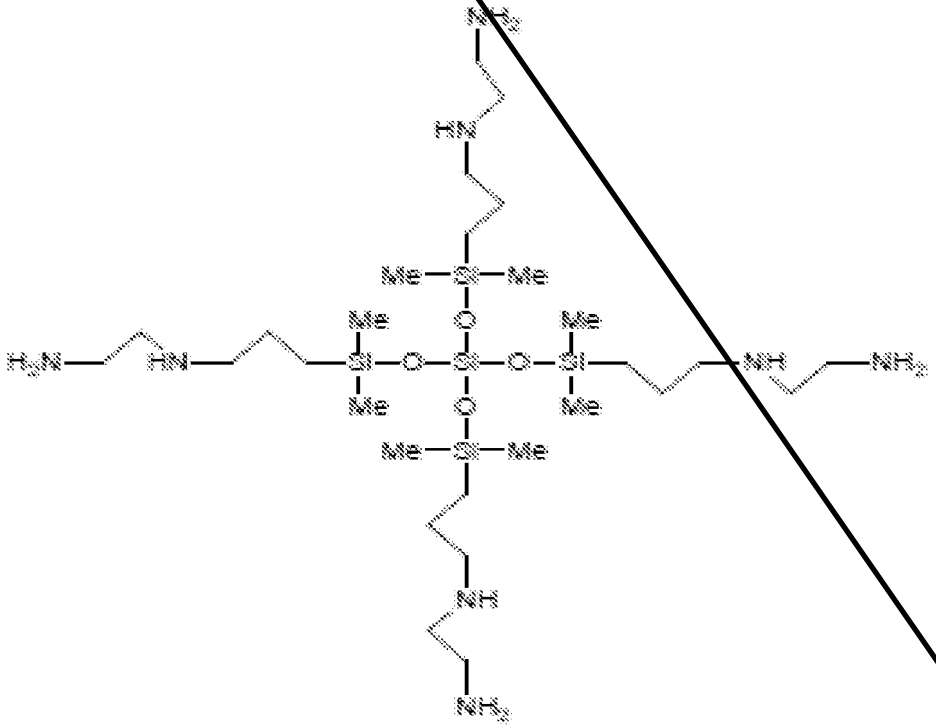
,



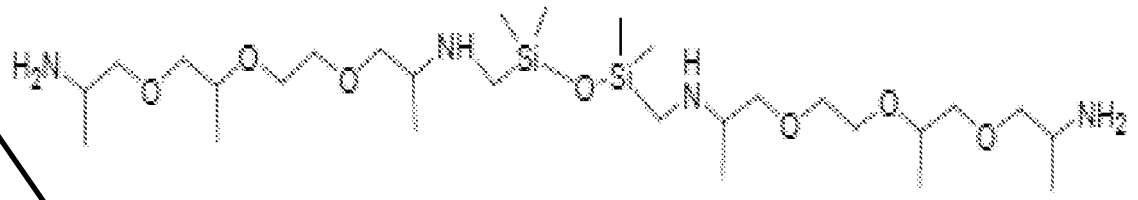
,



,

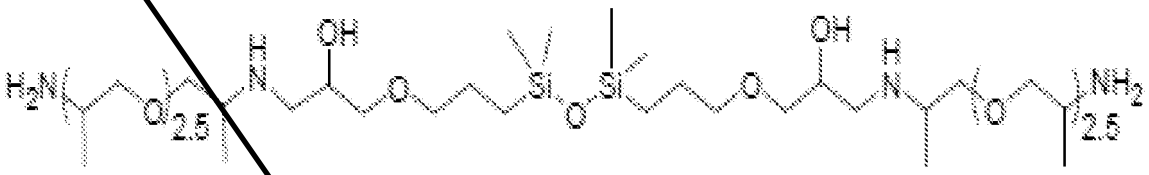


,



,

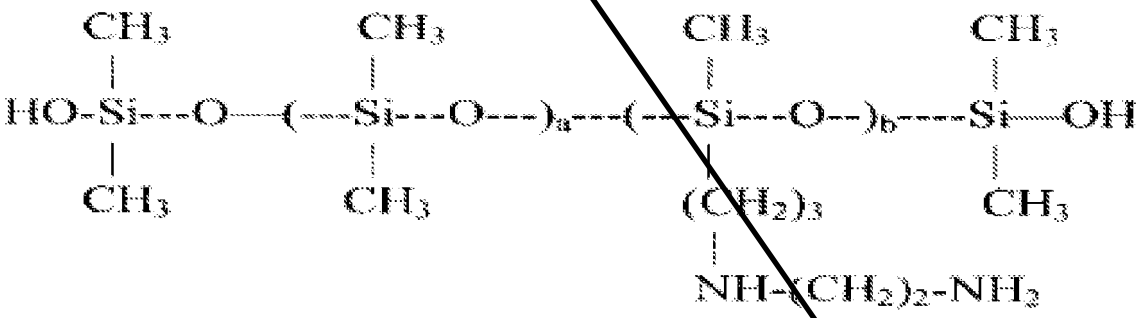
and



.

13. The membrane of claim 12, wherein the porous substrate is selected from the group consisting of: fibrous and nanofibrous webs; sintered metals; sintered ceramics; polysulfones; polycarbonates; micro-porous polyolefins; polyamides; polyimides; polynitriles; polyimines; polyphenylene ethers; polyketones; polyetherketones; halogenated polymers; polyvinylidine fluoride and combinations thereof.

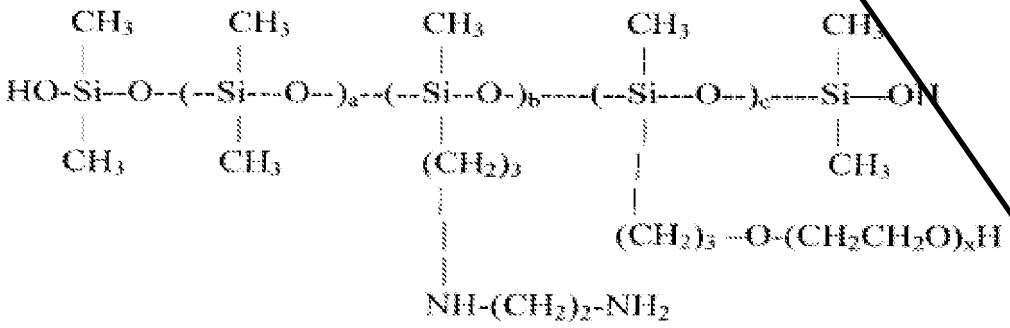
14. The membrane of claim 12, wherein the additive is a compound of the formula:



,

wherein a and b are integers between 1 and 100 and the sum of a + b is less than about 100.

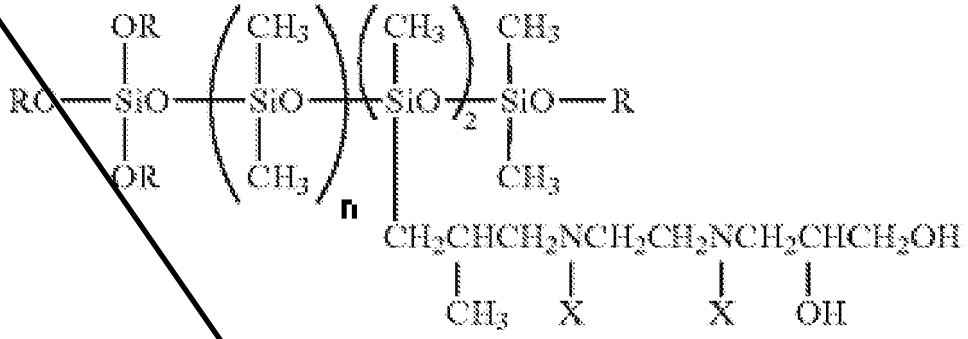
15. The membrane of claim 12, wherein the additive is a compound of the formula:



,

wherein a, b and c are integers between 1 and 100, the sum of a+b+c is less than about 100; and x is an integer between 1 and 50.

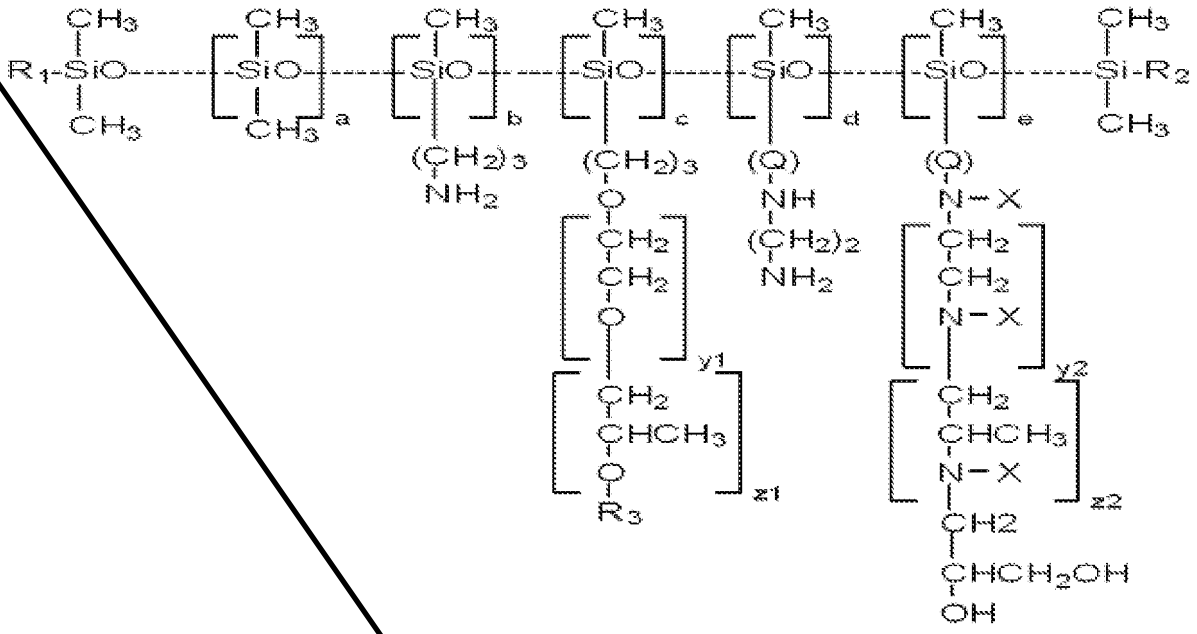
16. The membrane of claim 12, wherein the additive is a compound of the formula:



,

wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of $-CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and about 100.

17. A composite membrane for reverse osmosis or nanofiltration, the membrane comprising:
a porous substrate;
a polymer layer on a surface of the porous substrate, wherein the polymer layer comprises a reaction product of an organic phase, an aqueous phase and an additive, wherein the organic phase comprises polyacyl halides, the aqueous phase comprises amines and the additive is a compound of the formula:



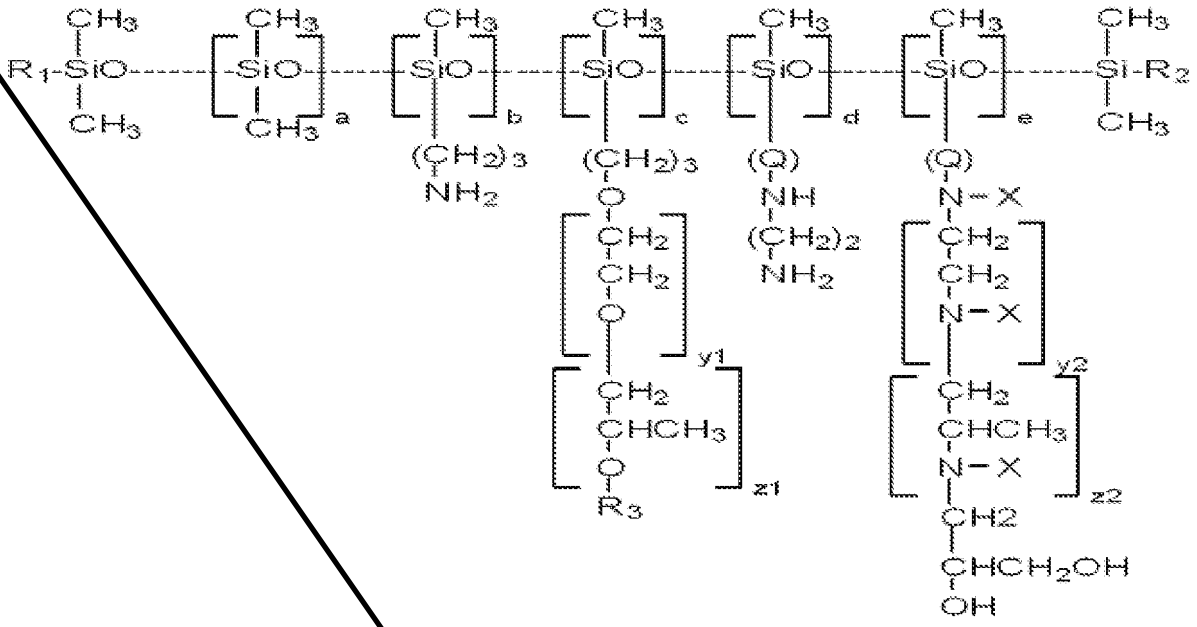
wherein R1 and R2 may be the same or different, and are C1-C20 alkyl or alkoxy groups; R3 may be a C1-C4 alkyl group, or H; Q is either $-(CH_2)^3-$ or $-CH_2CH(CH_3)CH_2-$; X is either $-CH_2CH(OH)CH_2OH$ or H; a, b, c, d, e are integers such that the sum of a+b+c+d+e is less than 100, if b is 0, then d or e must be greater than 0, if d is 0, then b or e must be greater than 0; and if e is 0, then b or d must be greater than 0; and, y1, y2, z1, z2 are each integers between 0 to 10.

18. A composite membrane for reverse osmosis or nanofiltration, the membrane comprising:

a porous substrate;

a polymer layer on a surface of the porous substrate, wherein the polymer layer comprises a reaction product of an organic phase, an aqueous phase and an amino-siloxane compound, wherein the organic phase comprises polyacyl halides and the aqueous phase comprising amines.

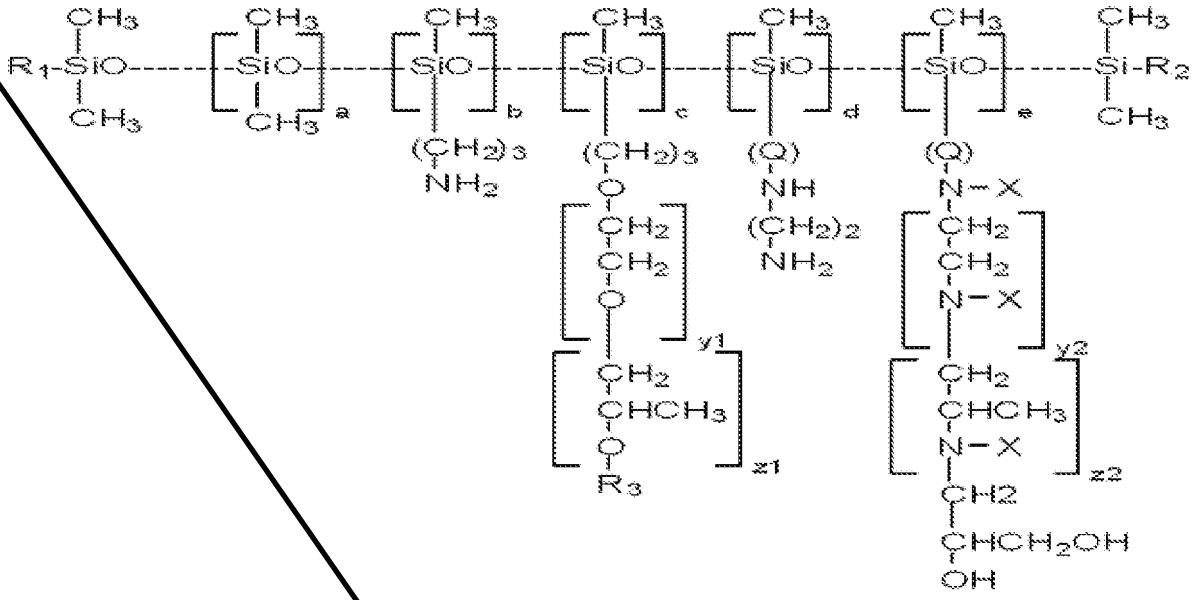
19. A compound formed by reacting an organic phase and an additive, the organic phase comprising a polyacyl halide and the additive is a compound of the formula:



,

wherein R1 and R2 may be the same or different, and are C1-C20 alkyl or alkoxy groups; R3 may be a C1-C4 alkyl group, or H; Q is either $-(CH_2)^3-$ or $-CH_2CH(CH_3)CH_2-$; X is either $-CH_2CH(OH)CH_2OH$ or H; a, b, c, d, e are integers such that the sum of a+b+c+d+e is less than 100, if b is 0, then d or e must be greater than 0, if d is 0, then b or e must be greater than 0; and if e is 0, then b or d must be greater than 0; and, y1, y2, z1, z2 are each integers between 0 to 10.

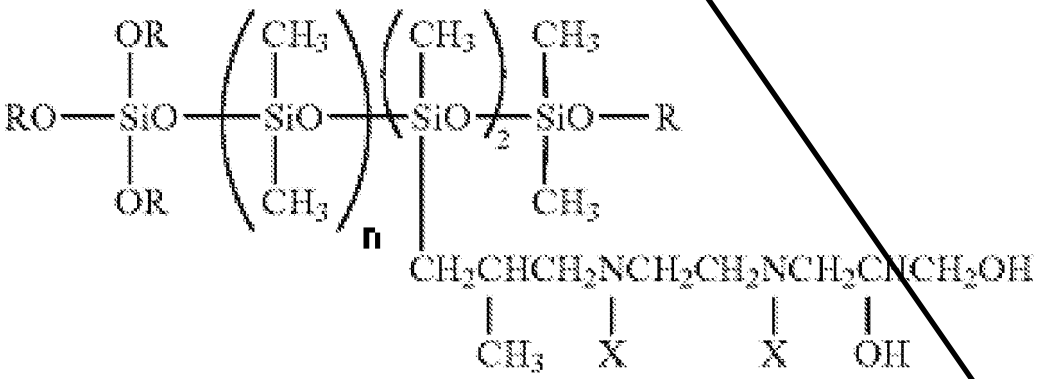
20. A compound formed by reacting an aqueous phase, an organic phase and an additive, wherein the aqueous phase comprises an amine, the organic phase comprises a polyacyl halide and the additive is a compound of the formula:



,

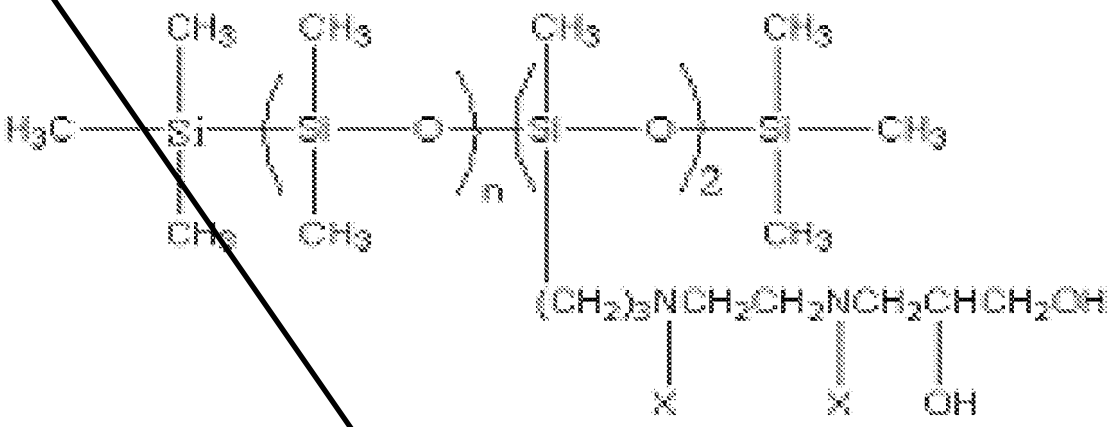
wherein R1 and R2 may be the same or different, and are C1-C20 alkyl or alkoxy groups; R3 may be a C1-C4 alkyl group, or H; Q is either $-(CH_2)^3$- or $-CH_2CH(CH_3)CH_2$-; X is either $-CH_2CH(OH)CH_2OH$ or H; a, b, c, d, e are integers such that the sum of a+b+c+d+e is less than 100, if b is 0, then d or e must be greater than 0, if d is 0, then b or e must be greater than 0; and if e is 0, then b or d must be greater than 0; and, y1, y2, z1, z2 are each integers between 0 to 10.

21. A compound formed by reacting an organic phase and an additive, wherein the organic phase comprises a polyacyl halide and the additive is a compound of the formula:



wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of $-CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and 100.

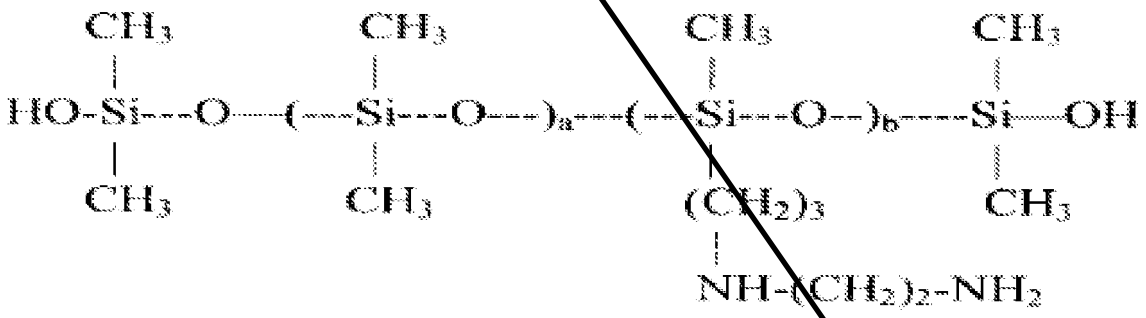
22. A compound formed by reacting an organic phase and an additive, wherein the organic phase comprises a polyacyl halide and the additive is a compound of the formula:



,

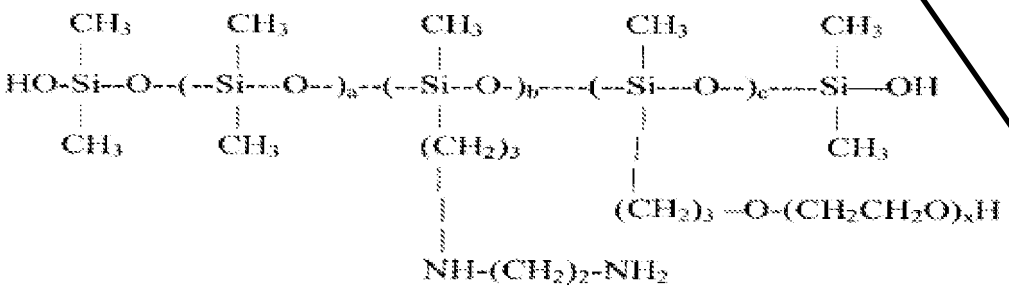
wherein x is either $-CH_2CH(OH)CH_2OH$ or H; and n is an integer between 4 and 100.

23. A compound formed by reacting an organic phase and an additive, wherein the organic phase comprises a polyacyl halide and the additive is a compound selected from the group consisting of:



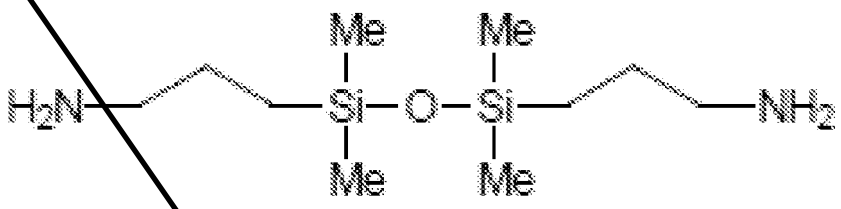
,

wherein a and b are integers between 1 and 100 and the sum of a + b is not greater than 100;

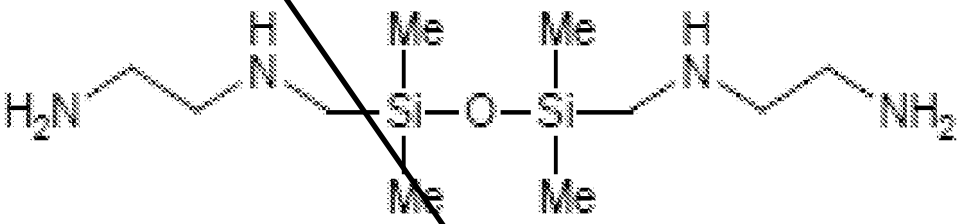


,

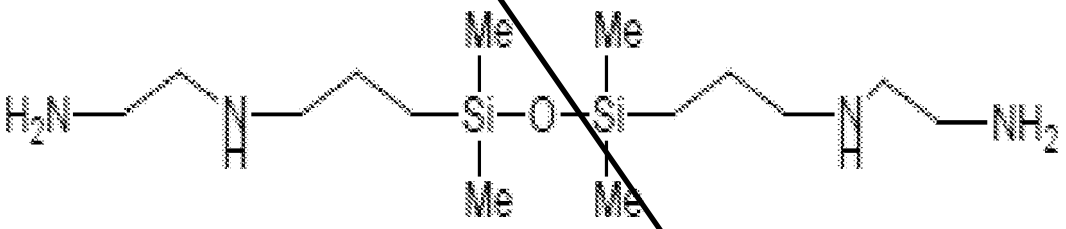
wherein a, b and c are integers between 1 and 100, the sum of a+b+c is not greater than 100 and x is an integer between 1 and 50;



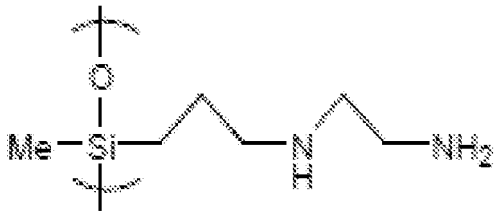
,



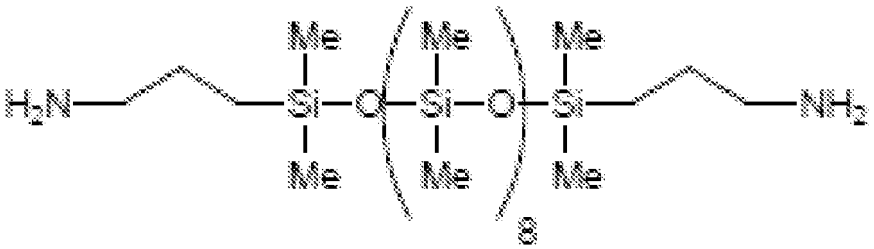
,



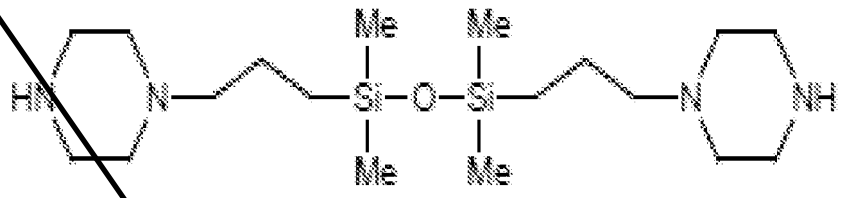
,



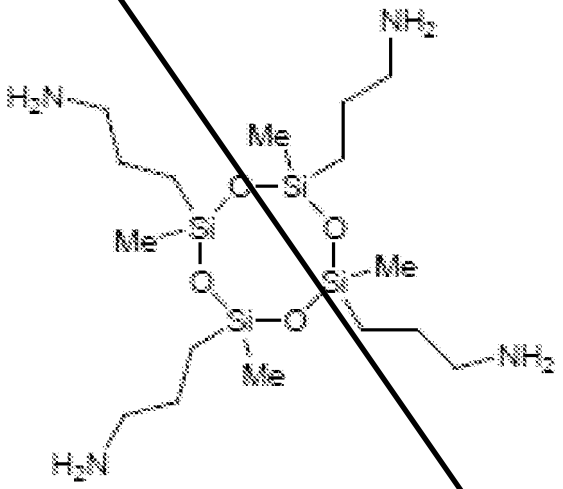
,



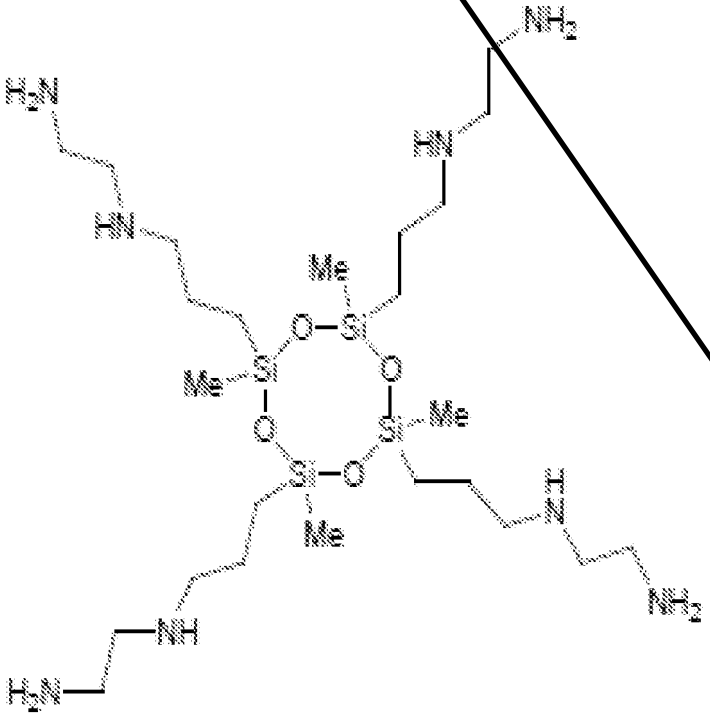
,



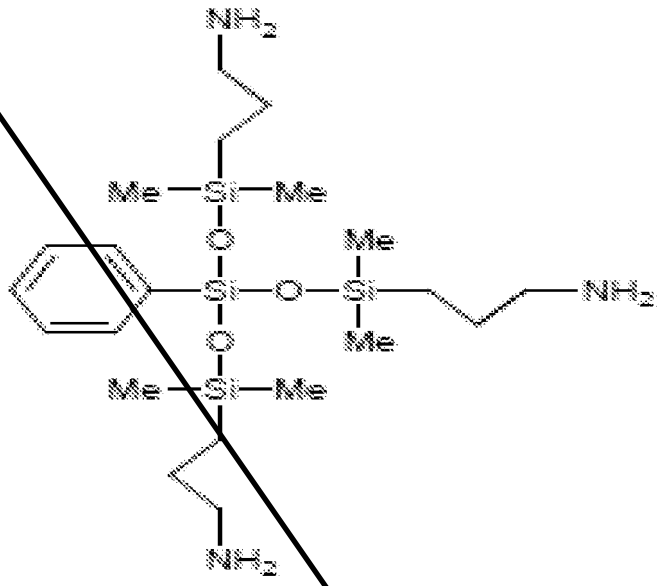
,



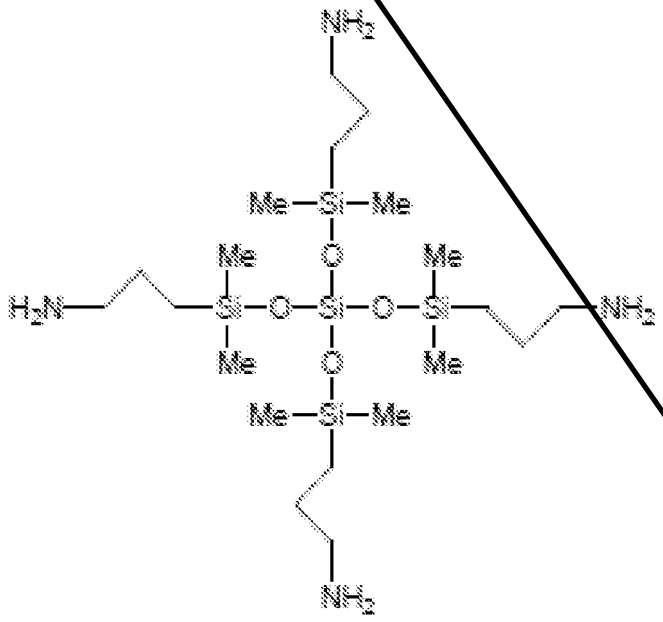
,



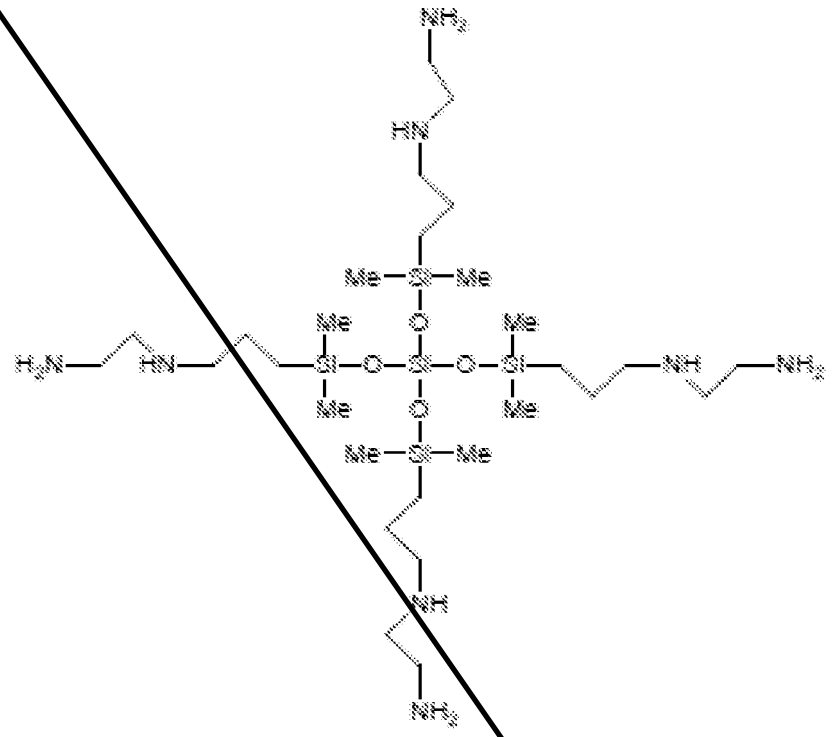
,



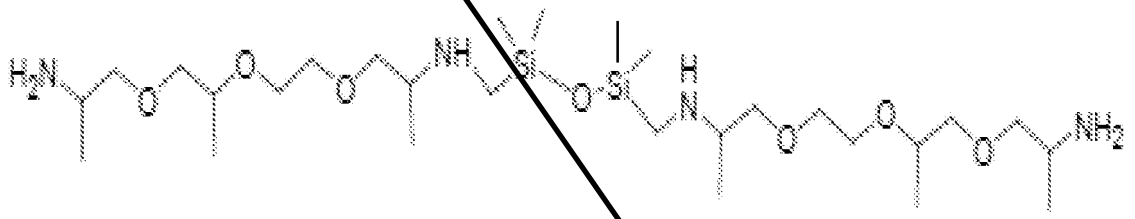
,



,

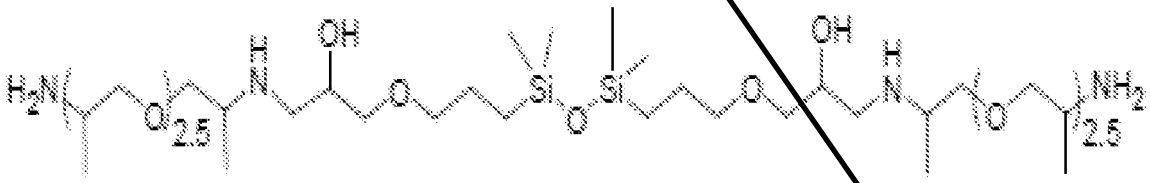


,



,

and

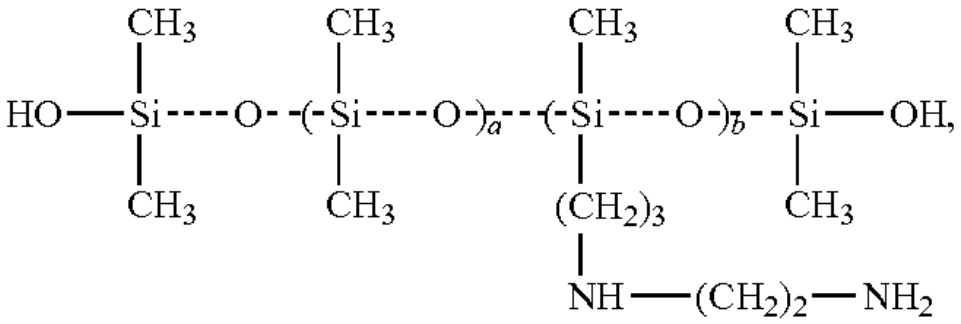


.

24. The compound of claim 19, wherein the polyacyl halide is trimesoyl chloride.

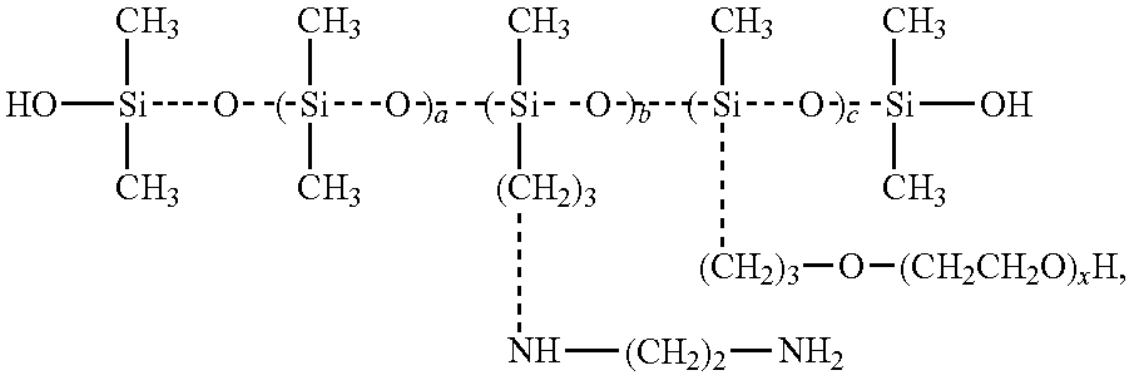
CLAIMS

1. A method for preparing a polyamide composite membrane, the method comprising: reacting an aqueous phase, an organic phase and an additive, wherein the aqueous phase comprises an amine that is different than the additive, the organic phase comprises a polyacyl halide and the additive is a compound selected from the group consisting of:

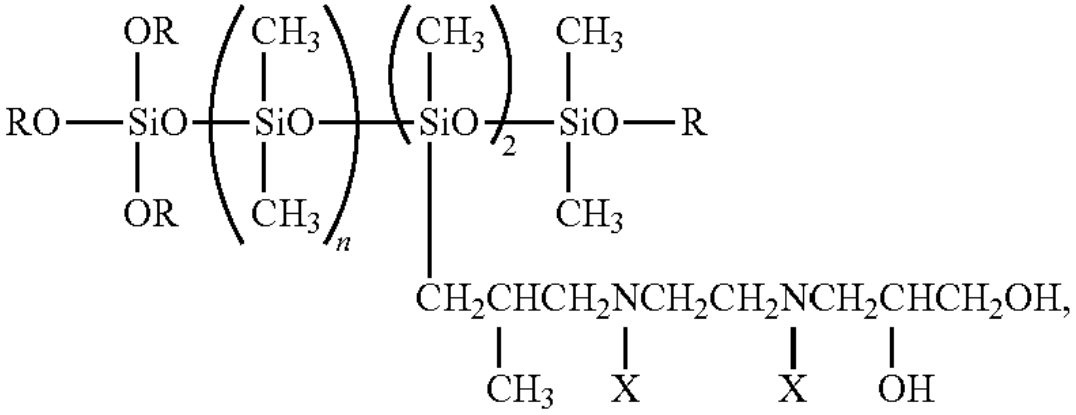


,

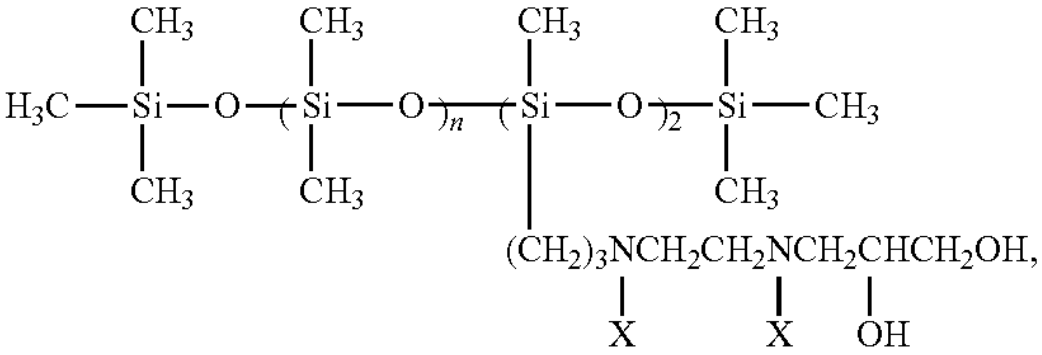
wherein a and b are integers between 1 and 100 and the sum of a + b is not greater than 100;



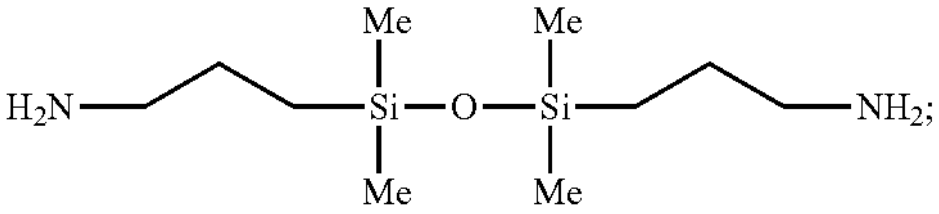
wherein a, b and c are integers between 1 and 100, the sum of a+b+c is not greater than 100 and x is an integer between 1 and 50;

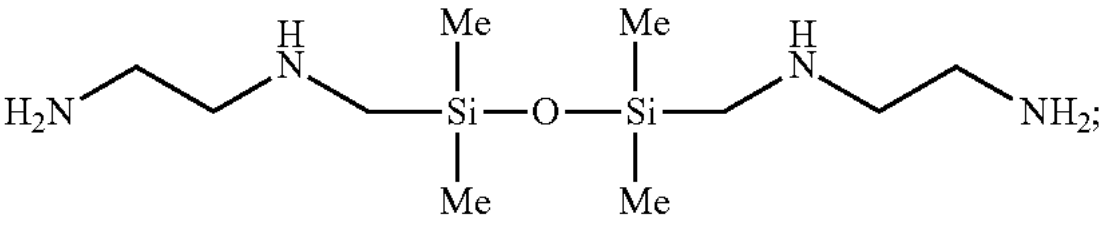


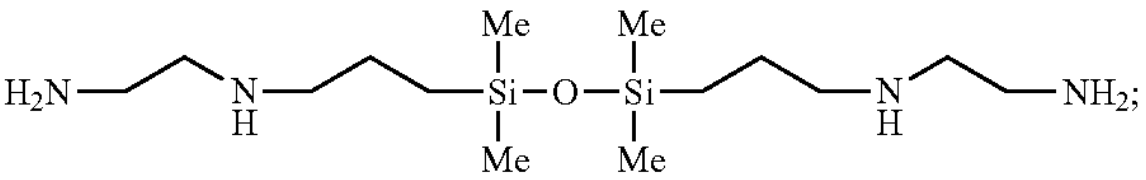
wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of -$CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and 100;

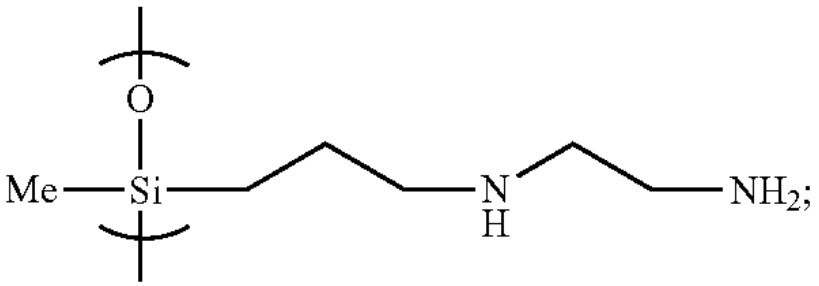


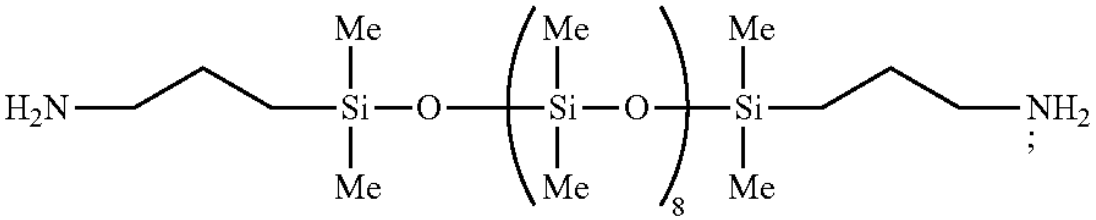
wherein x is either -$CH_2CH(OH)CH_2OH$ or H; and n is an integer between 4 and 100;

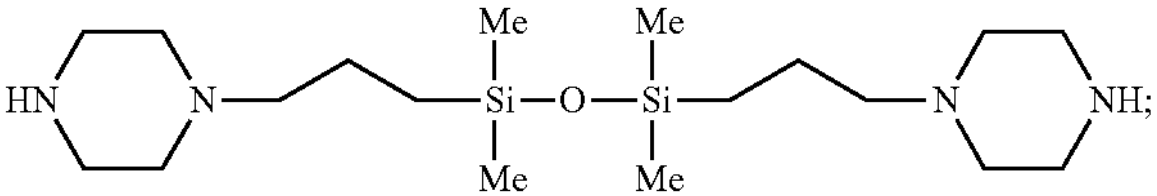


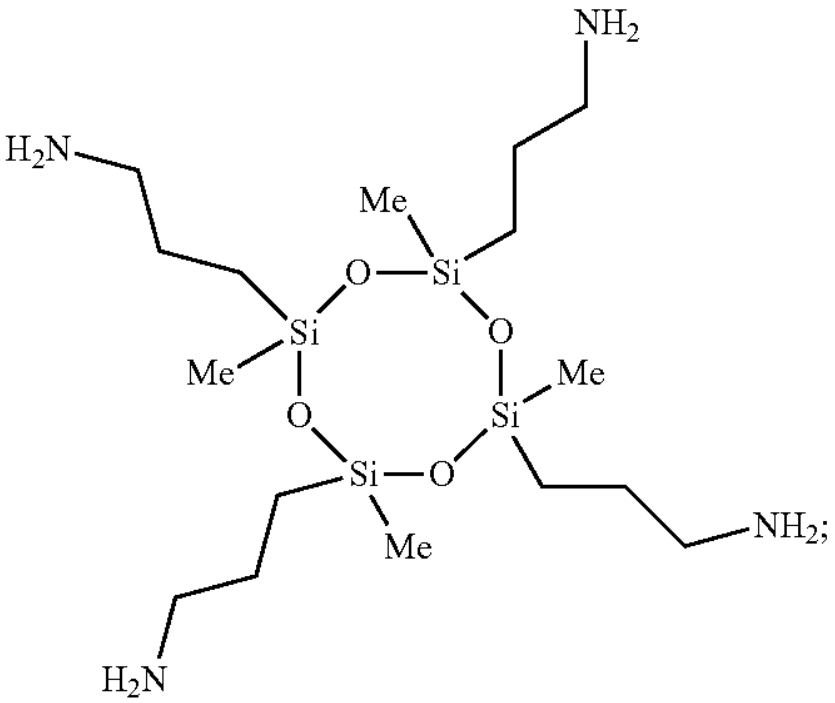


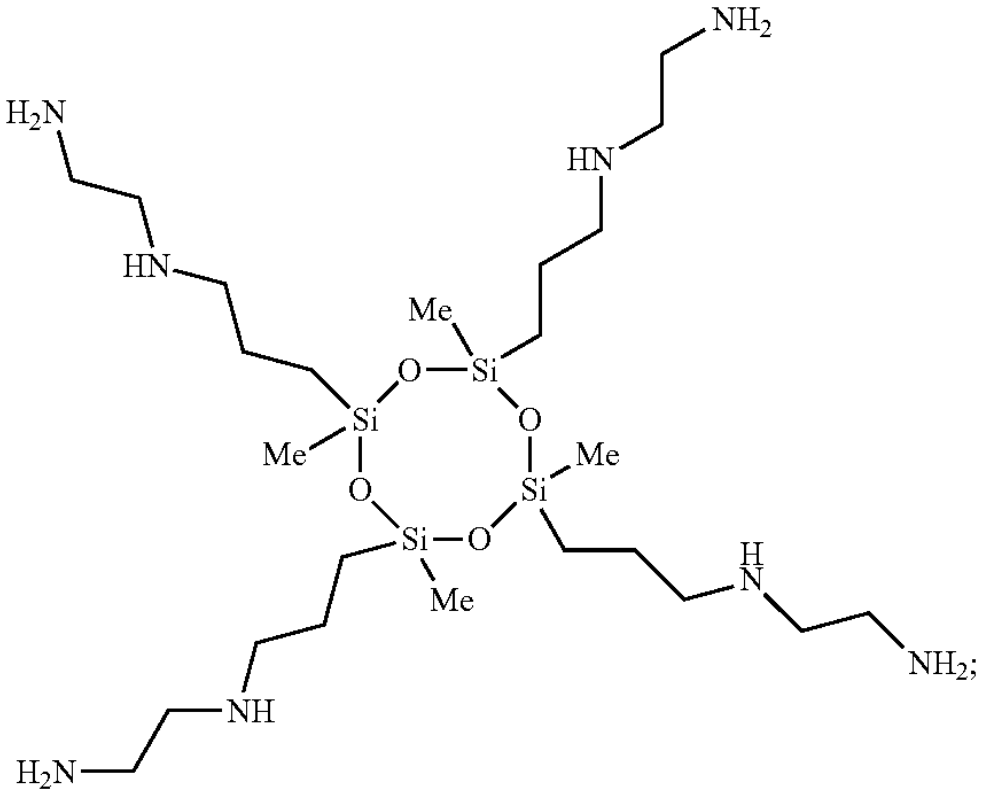


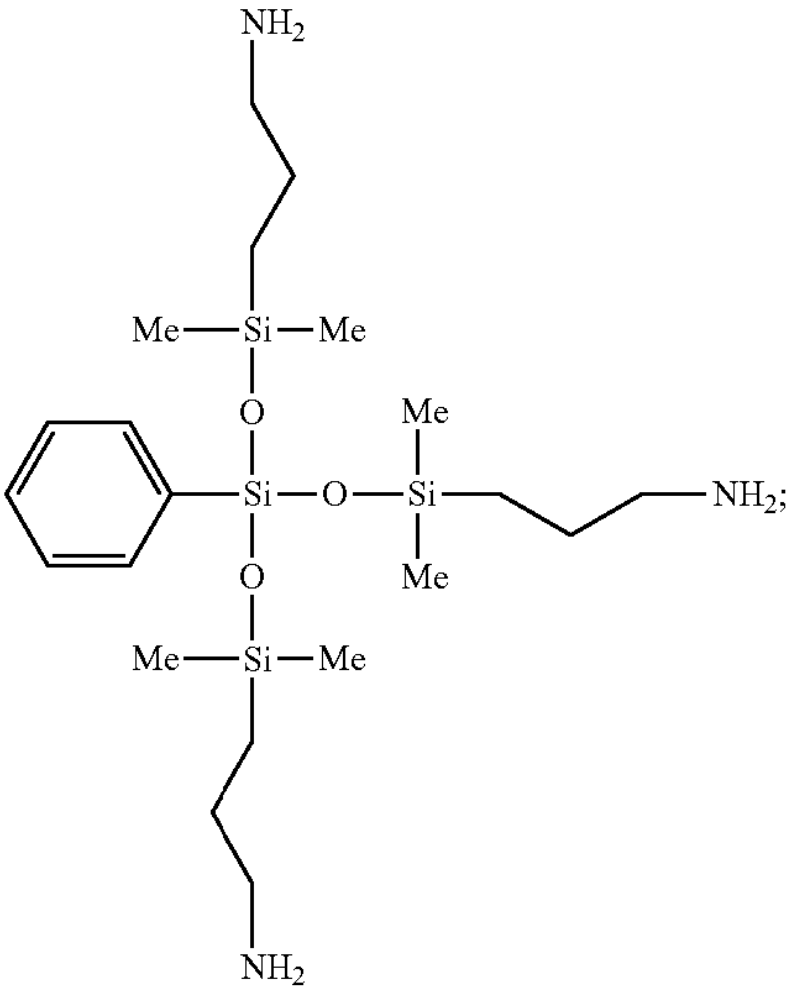


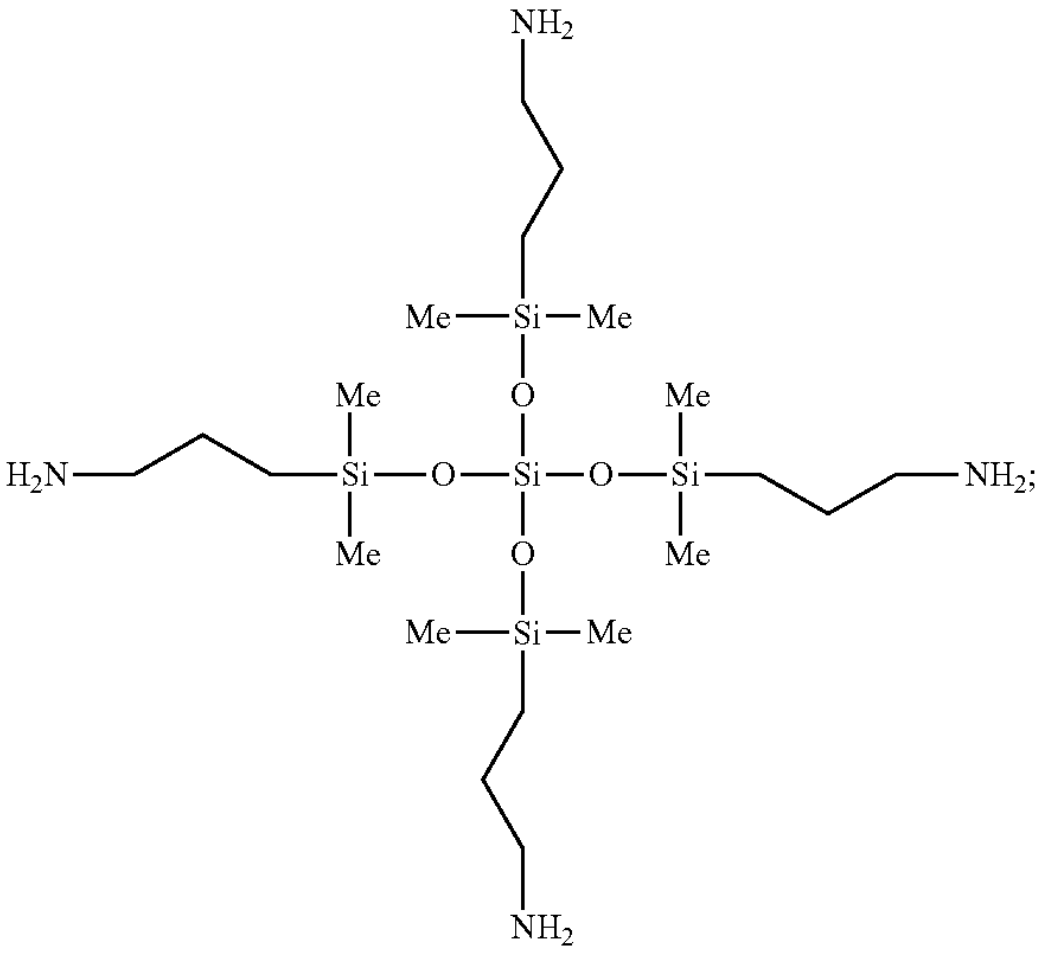


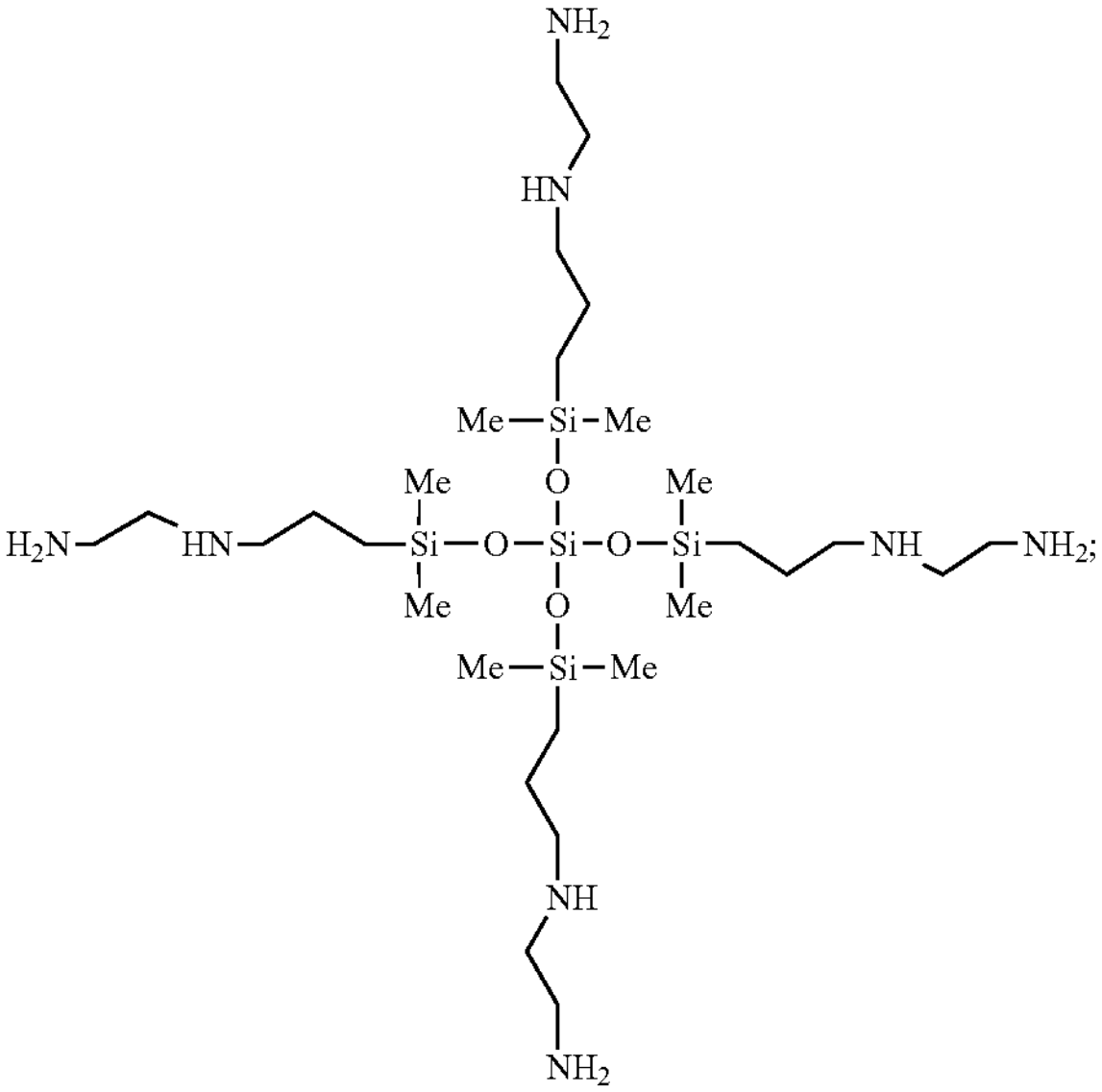


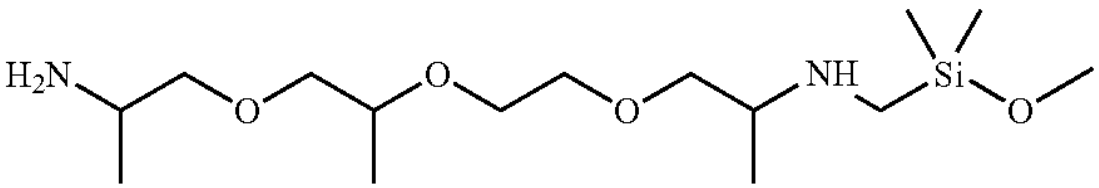

NH2
H2N
Me
O
Si
Si
O
Me
Me
O
Si
Si
O
Me
NH2;
H2N

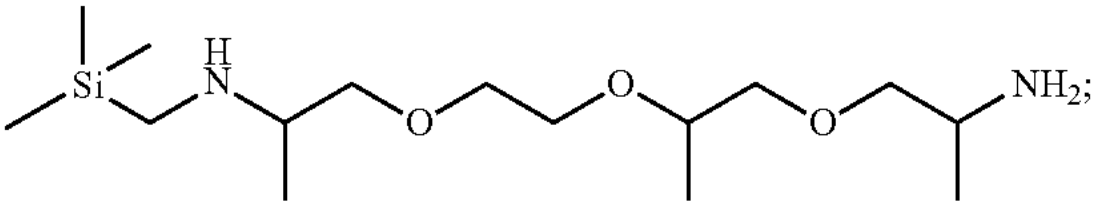

NH2
H2N
HN
HN
Me
O
Si
Si
O
Me
Me
O
Si
Si
O
Me
H
N
NH2;
NH
H2N


NH2
Me
Si
Me
O
Me
Si
O
Si
NH2;
O
Me
Me
Si
Me
NH2

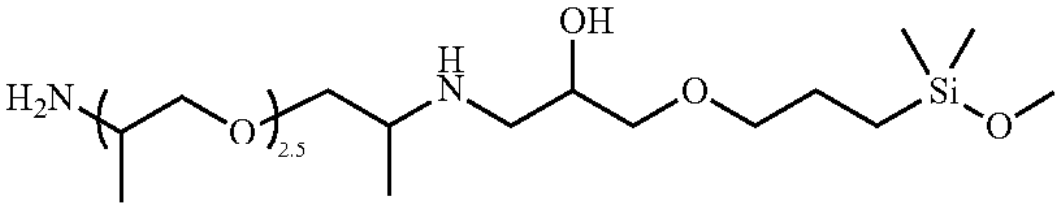

NH2
Me
Si
Me
Me
O
Me
H2N
Si
O
Si
O
Si
NH2;
Me
O
Me
Me
Si
Me
NH2

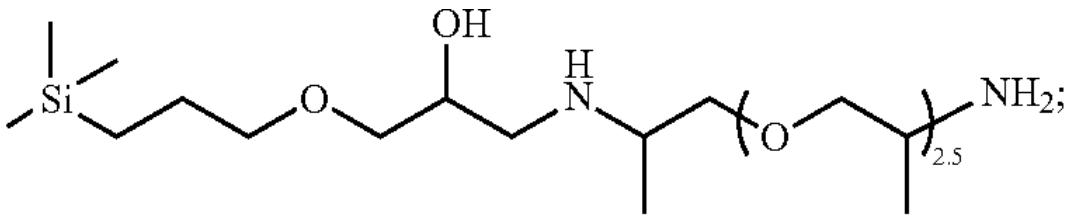






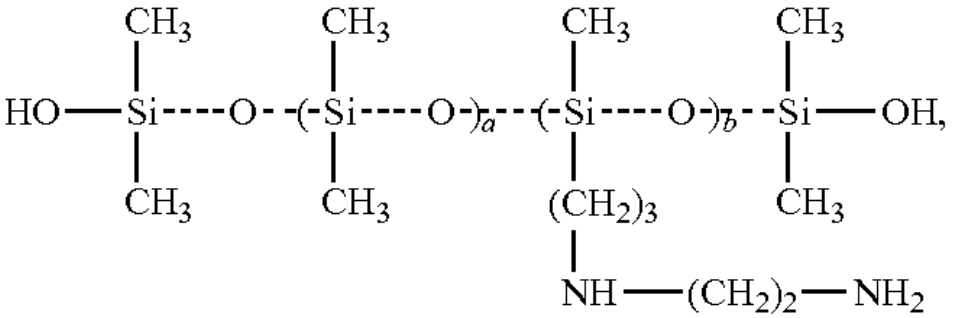
and





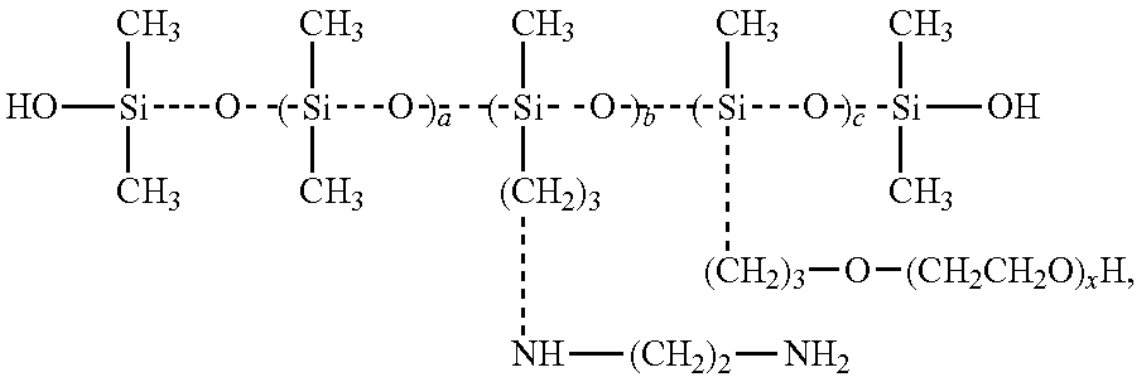
wherein the reaction occurs at or near the surface of a substrate.

2. The method of claim 1, wherein the additive is a compound of the formula:



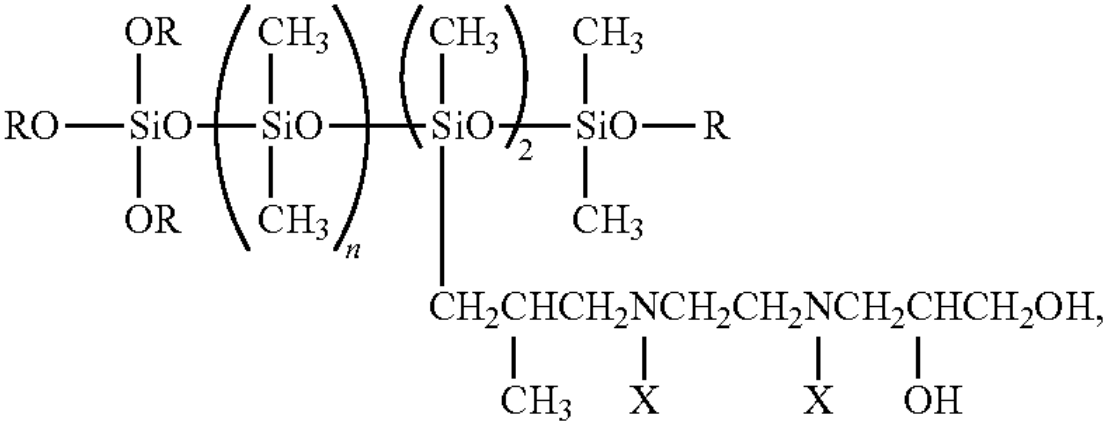
wherein a and b are integers between 1 and 100 and the sum of a + b is less than about 100.

3. The method of claim 1, wherein the additive is a compound of the formula:



wherein a, b and c are integers between 1 and 100, the sum of a+b+c is less than about 100; and x is an integer between 1 and 50.

4. The method of claim 1, wherein the additive is a compound of the formula:



wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of $-CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and about 100.

5. The method of claim 1, wherein the amine is selected from the group consisting of: cyclic polyfunctional amines; acyclic polyfunctional amines; substituted cyclic polyfunctional amines; aromatic polyfunctional amines; substituted aromatic

polyfunctional amines; multi-aromatic ring polyfunctional amines; substituted multi-aromatic ring polyfunctional amines; and combinations thereof.

6. The method of claim 1, wherein the amine is selected from the group consisting of: piperazine; 1,2-ethanediamaine; methyl piperazine; dimethyl piperazine; m-phenylenediamine; o-phenylenediamine; p-phenylenedamine; chlorophenylenediamine; N,N^{l}-dimethyl-1,3-phenylenediamine; benzidine; 3,3^{l}-dimethylbenzidene, 3,3^{l}-dichlorobenzidine, and combinations thereof.

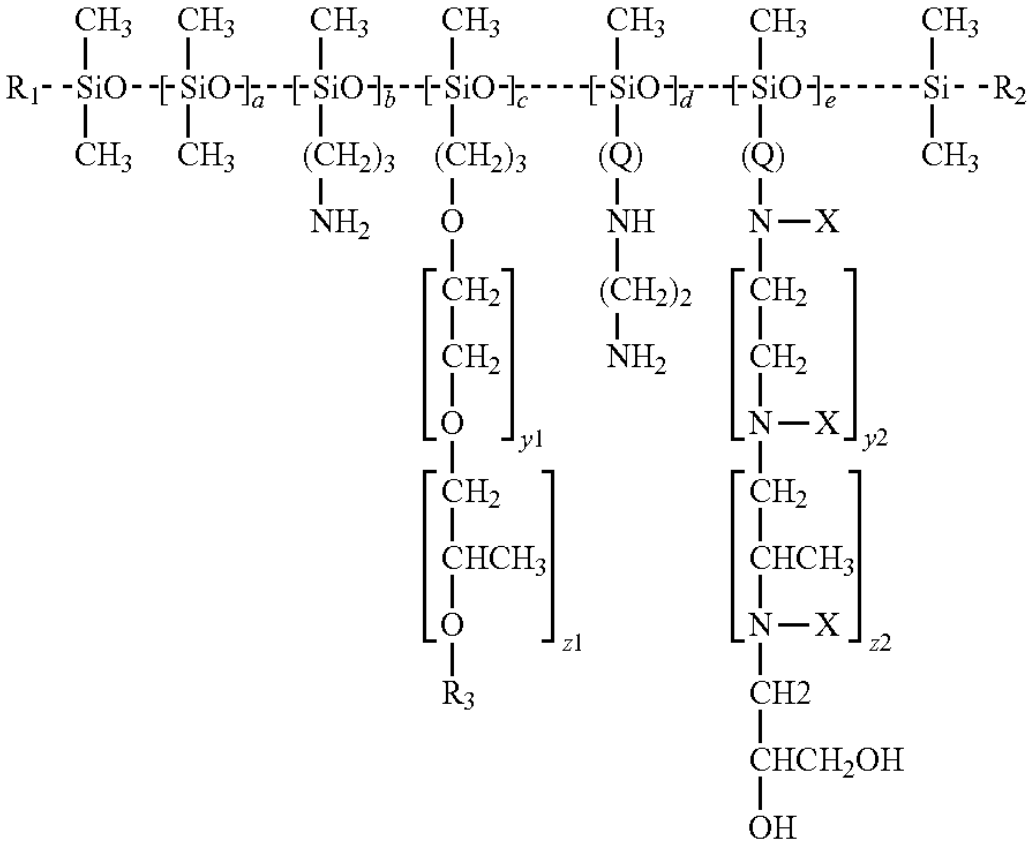
7. The method of claim 1, wherein the organic phase comprises a compound selected from the group consisting of: di-carboxylic acid halides; tri-carboxylic acid halides; di-tri carboxylic acid halides; tri-tri carboxylic acid halides; isomeric phthaloyl halides; aromatic di-sulfonyl halides; tri-sulfonyl halides; aromatic di-isocyanates; aromatic tri-isocyanates, aromatic di-chloroformates; aromatic tri-chloroformates, aromatic rings substituted with mixtures of the above and combinations thereof.

8. The method of claim 1, wherein the organic phase comprises a compound selected from the group consisting of: trimesoyl chloride (1,3,5-benzene tricarboxylic acid chloride), isophthaloyl chloride, terephthaloyl chloride, 1,3,5-cyclohexanetricarbonyl chloride, 1,2,3,4-cyclopentanetetracarbonyl chloride, trimesoyl bromide (1,3,5-benzene tricarboxylic acid bromide), isophthaloyl bromide, terephthaloyl bromide, trimesoyl iodine (1,3,5-benzene tricarboxylic acid iodide), isophthaloyl iodide, terephthaloyl iodide and combinations thereof.

9. The method of claim 1, wherein the substrate is selected from the group consisting of: fibrous and nanofibrous webs; sintered metals; sintered ceramics; polysulfones; polycarbonates; micro-porous polyolefins; polyamides; polyimides; polynitriles; polyimines; polyphenylene ethers; polyketones; polyetherketones; halogenated polymers; polyvinylidine fluoride and combinations thereof.

10. A method for preparing a polyamide composite membrane, the method comprising: reacting an aqueous phase, an organic phase and an additive, wherein the

aqueous phase comprises an amine, the organic phase comprises a polyacyl halide and the additive is a compound of the formula:



wherein R1 and R2 may be the same or different, and are C1-C20 alkyl or alkoxy groups; R3 may be a C1-C4 alkyl group, or H; Q is either $–(CH_2)^3$- or $–CH_2CH(CH_3)CH_2$—; X is either $–CH_2CH(OH)CH_2OH$ or H; a, b, c, d, e are integers such that the sum of a+b+c+d+e is less than 100, if b is 0, then d or e must be greater than 0, if d is 0, then b or e must be greater than 0; and if e is 0, then b or d must be greater than 0; and, y1, y2, z1, z2 are each integers between 0 to 10;

wherein the reaction occurs at or near the surface of a substrate.

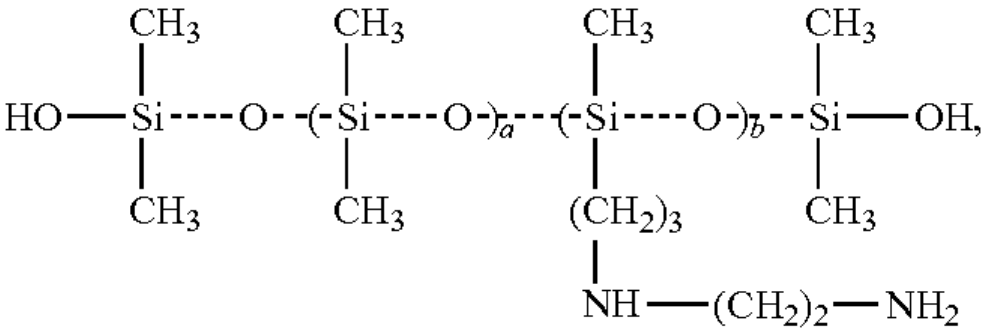
11. A method of filtering an aqueous solution, the method comprising:

filtering the aqueous solution through a polyamide composite membrane prepared by the method of claim 1 in a reverse osmosis process or a nanofiltration process.

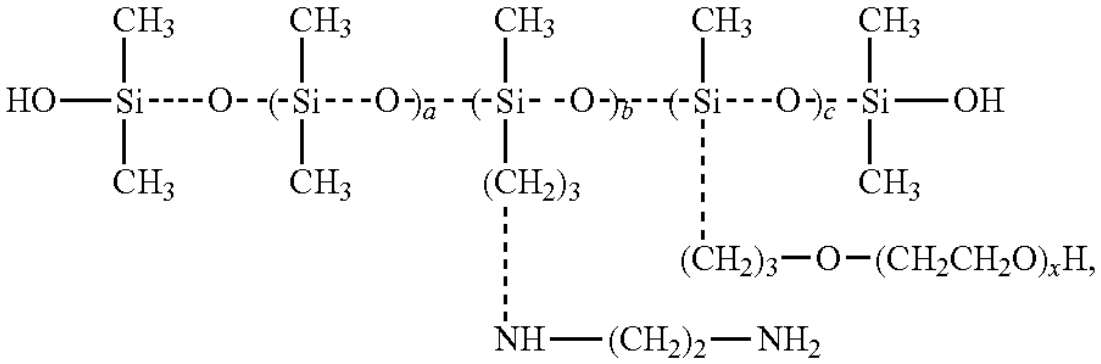
12. A composite membrane for reverse osmosis or nanofiltration, the membrane comprising:

a porous substrate;

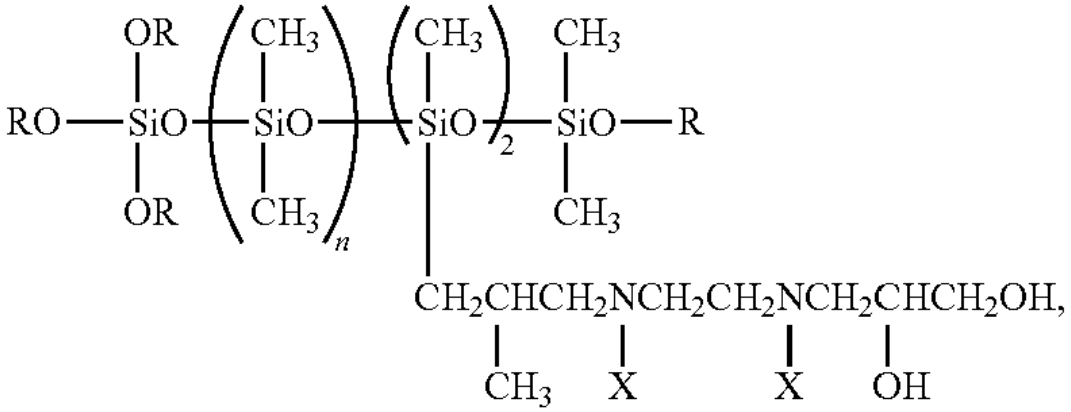
a polymer layer on a surface of the porous substrate, wherein the polymer layer comprises a polyamide that is a reaction product of an aqueous phase, an organic phase and an additive, wherein the aqueous phase comprises an amine that is different that the additive, the organic phase comprises a polyacyl halide, and the additive is selected from the group consisting of:



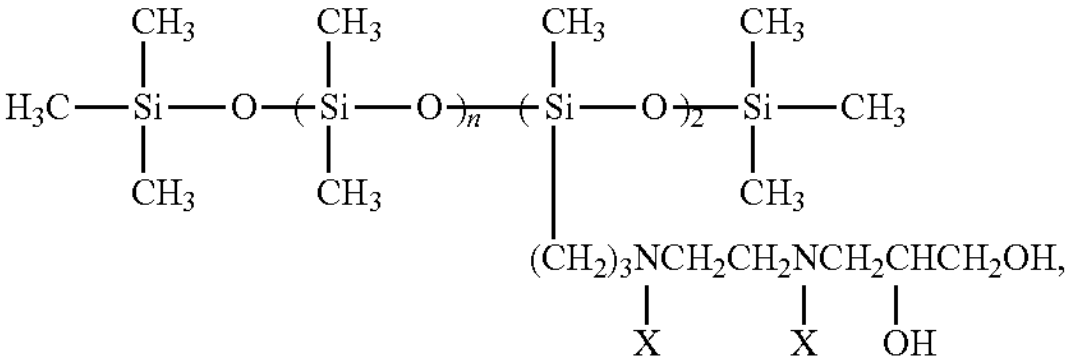
wherein a and b are integers between 1 and 100 and the sum of a + b is not greater than 100;



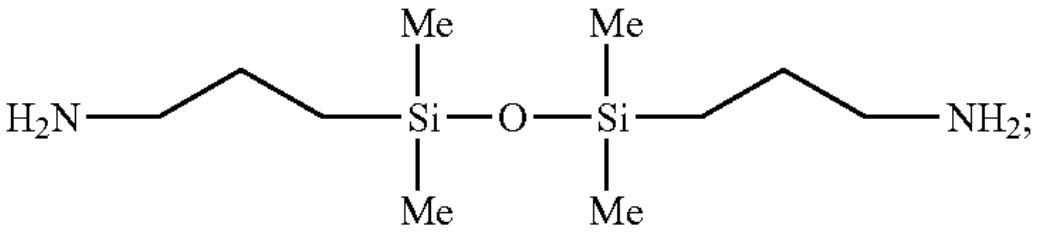
wherein a, b and c are integers between 1 and 100, the sum of a+b+c is not greater than 100 and x is an integer between 1 and 50;

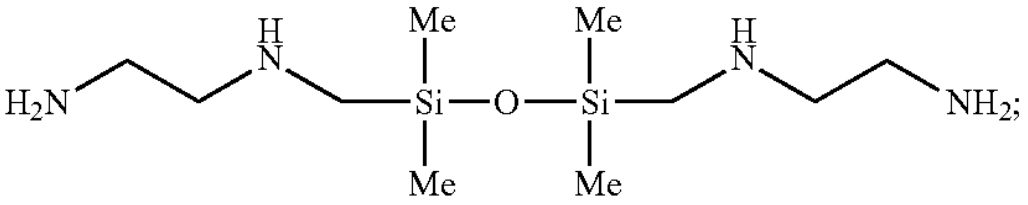


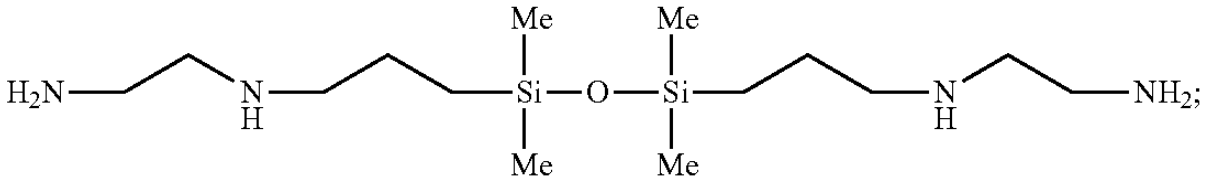
wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of -$CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and 100;

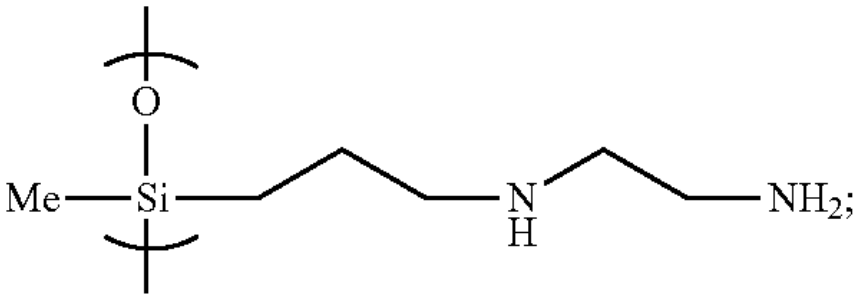


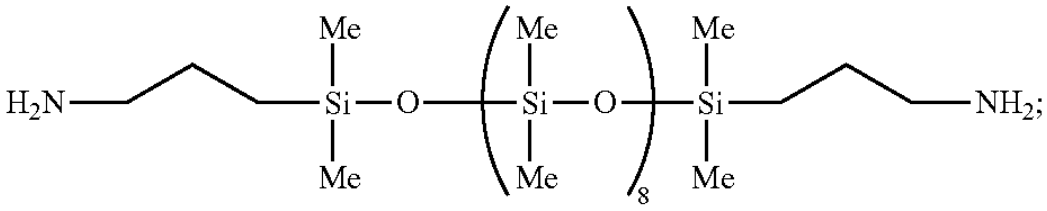
wherein x is either -$CH_2CH(OH)CH_2OH$ or H; and n is an integer between 4 and 100;

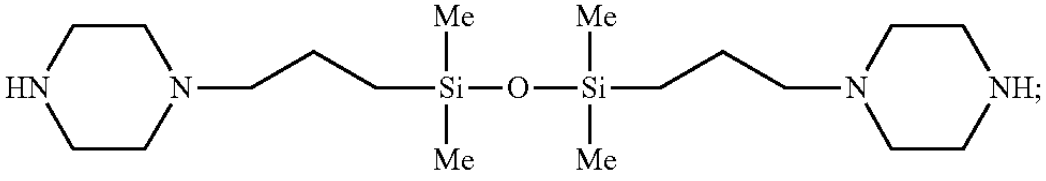


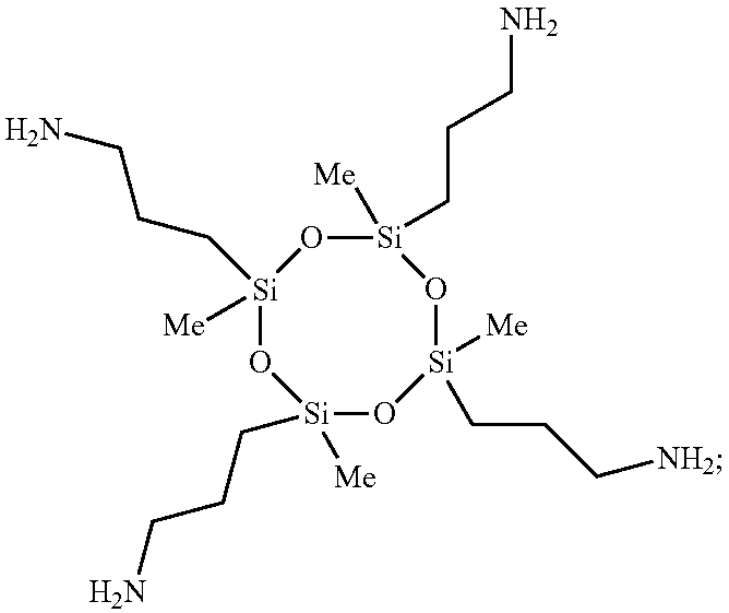


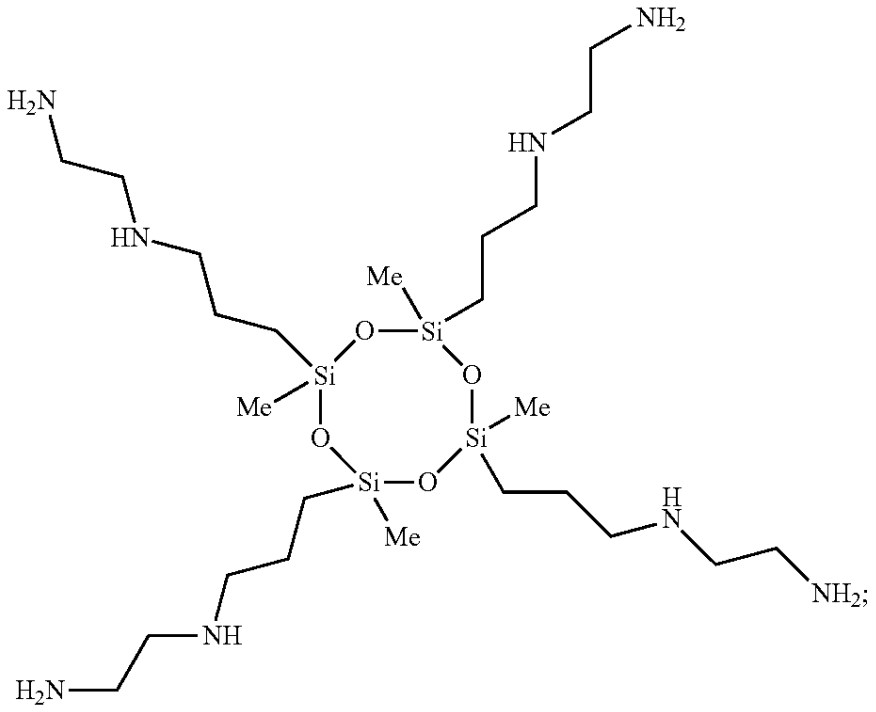


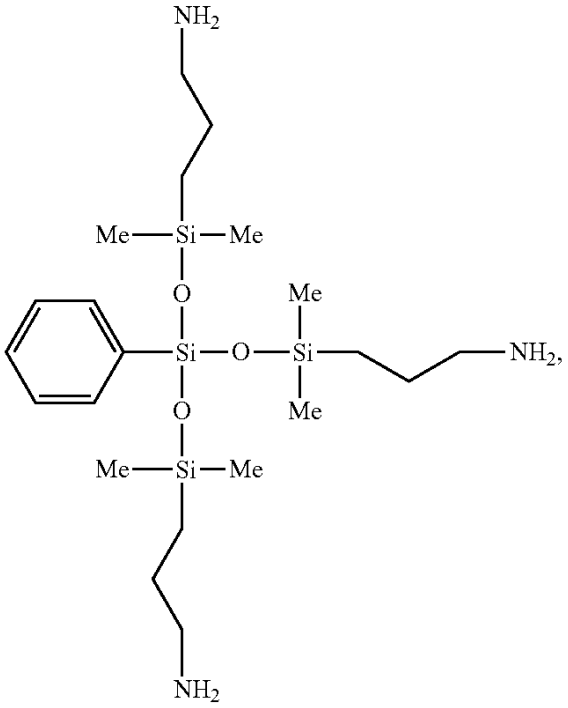


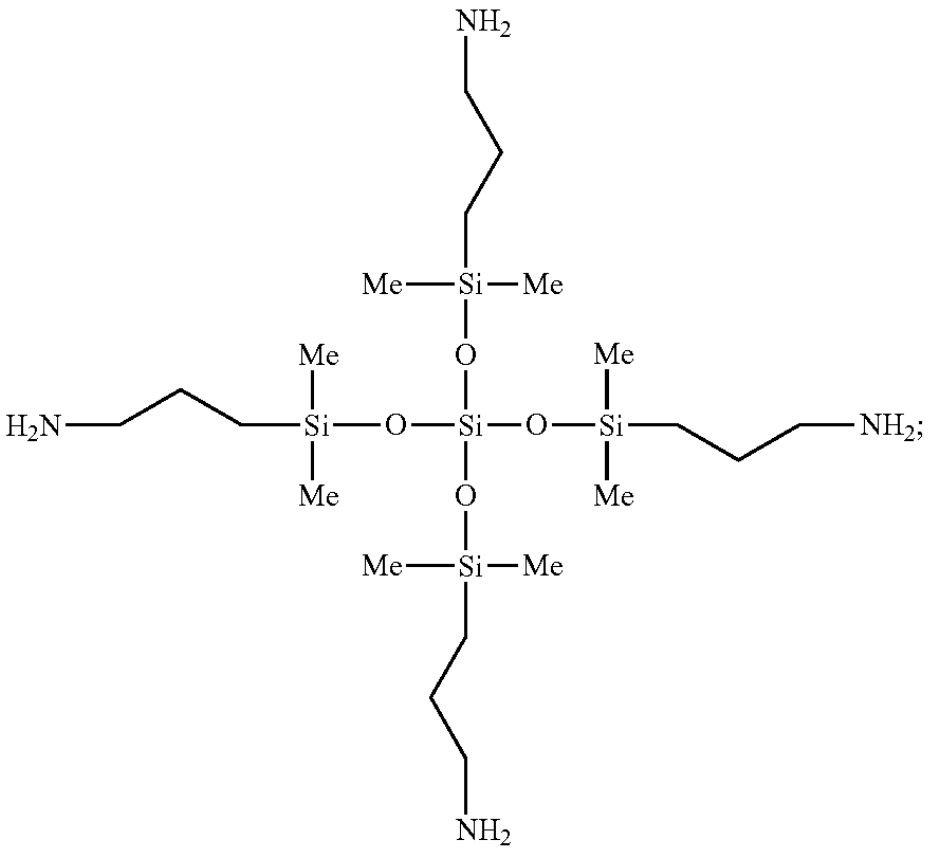


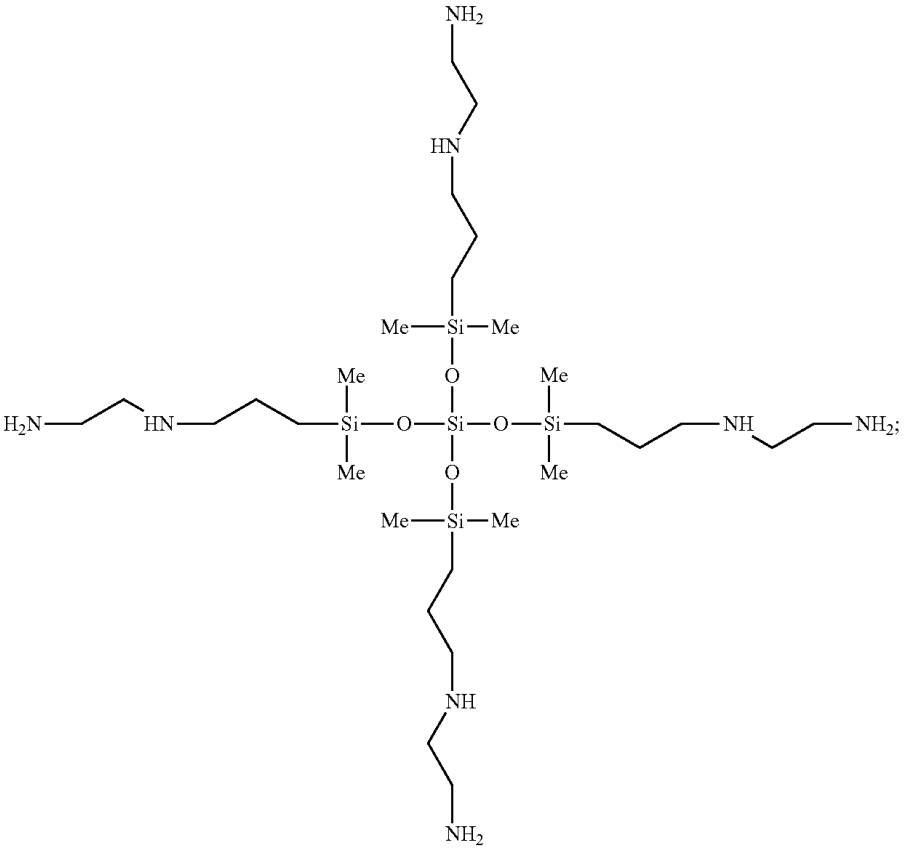


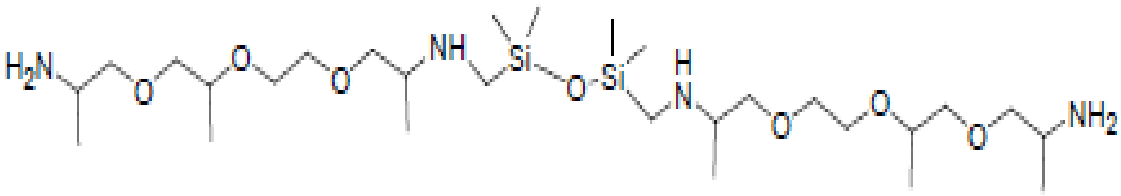

NH2
H2N
Me
O
Si
Si
O
Me
Me
O
Si
Si
O
Me
NH2;
H2N


NH2
H2N
HN
HN
Me
O
Si
Si
O
Me
Me
O
Si
Si
O
Me
H
N
NH2;
NH
H2N

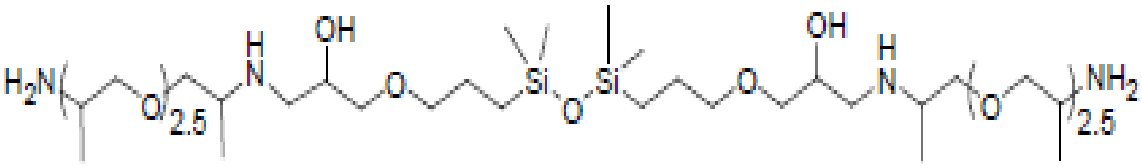





NH2
HN
Me Si Me
Me
O
Me
H2N
HN
Si
O
Si
O
Si
NH
NH2;
Me
O
Me
Me Si Me
NH
NH2


H2N
O
O
O
NH
Si
O
Si
H
N
O
O
O
NH2

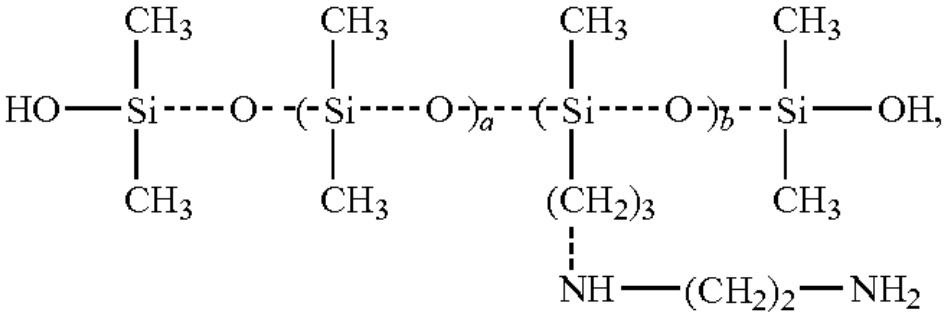
, and


H2N
O
2.5
H
N
OH
O
Si
O
Si
O
OH
H
N
O
NH2
2.5

.

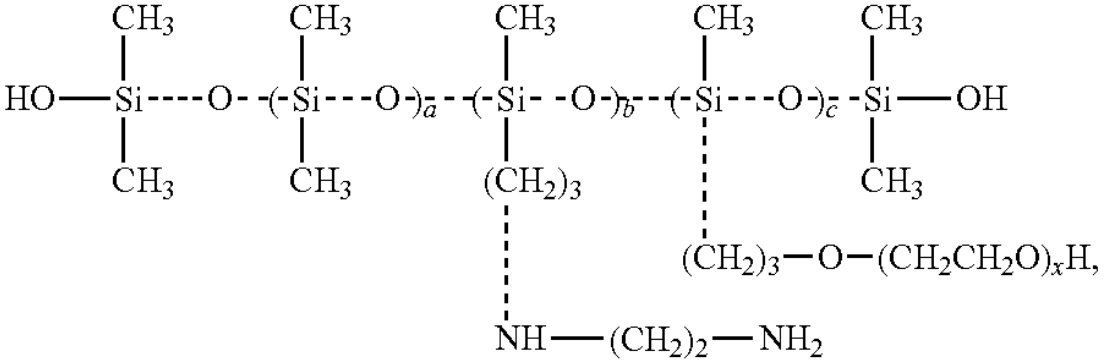
13. The membrane of claim 12, wherein the porous substrate is selected from the group consisting of: fibrous and nanofibrous webs; sintered metals; sintered ceramics; polysulfones; polycarbonates; micro-porous polyolefins; polyamides; polyimides; polynitriles; polyimines; polyphenylene ethers; polyketones; polyetherketones; halogenated polymers; polyvinylidine fluoride and combinations thereof.

14. The membrane of claim 12, wherein the additive is a compound of the formula:



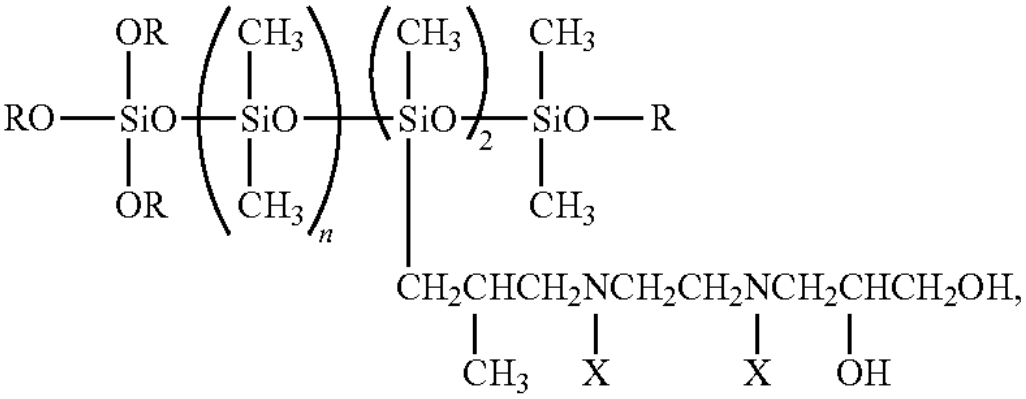
wherein a and b are integers between 1 and 100 and the sum of a + b is less than about 100.

15. The membrane of claim 12, wherein the additive is a compound of the formula:



wherein a, b and c are integers between 1 and 100, the sum of a+b+c is less than about 100; and x is an integer between 1 and 50.

16. The membrane of claim 12, wherein the additive is a compound of the formula:

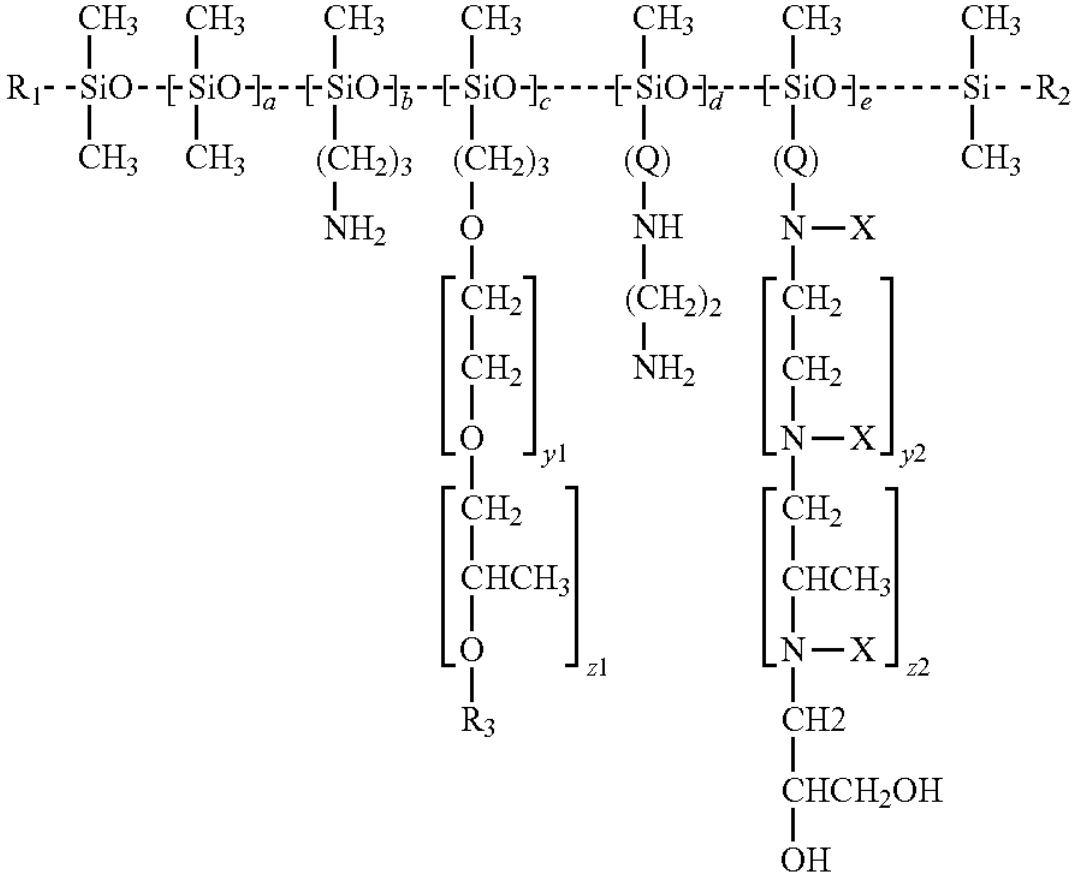


wherein R is CH_3 to $C_{15}H_{31}$; X is 75% of $-CH_2CH(OH)CH_2OH$ and 25% H; and n is an integer between 1 and about 100.

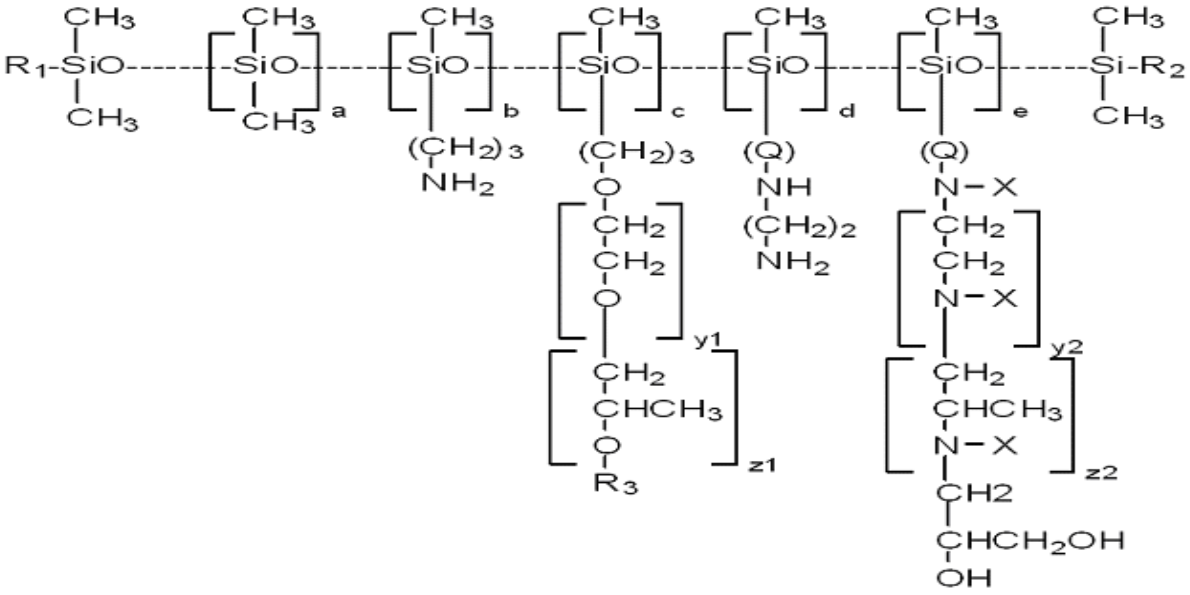
17. A composite membrane for reverse osmosis or nanofiltration, the membrane comprising:

a porous substrate;

a polymer layer on a surface of the porous substrate, wherein the polymer layer comprises a reaction product of an organic phase, an aqueous phase and an additive, wherein the organic phase comprises polyacyl halides, the aqueous phase comprises amines and the additive is a compound of the formula:



wherein R1 and R2 may be the same or different, and are C1-C20 alkyl or alkoxy groups; R3 may be a C1-C4 alkyl group, or H; Q is either $-(CH_2)^3-$ or $-CH_2CH(CH_3)CH_2-$; X is either $-CH_2CH(OH)CH_2OH$ or H; a, b, c, d, e are integers such that the sum of a+b+c+d+e is less than 100, if b is 0, then d or e must be greater than 0, if d is 0, then b or e must be greater than 0; and if e is 0, then b or d must be greater than 0; and, y1, y2, z1, z2 are each integers between 0 to 10.



wherein R1 and R2 may be the same or different, and are C1-C20 alkyl or alkoxy groups; R3 may be a C1-C4 alkyl group, or H; Q is either $–(CH_2)^3$- or $–CH_2CH(CH_3)CH_2$-; X is either $–CH_2CH(OH)CH_2OH$ or H; a, b, c, d, e are integers such that the sum of a+b+c+d+e is less than 100, if b is 0, then d or e must be greater than 0, if d is 0, then b or e must be greater than 0; and if e is 0, then b or d must be greater than 0; and, y1, y2, z1, z2 are each integers between 0 to 10.