WHAT IS CLAIMED IS:

1. A self-supported ion exchange membrane comprising:

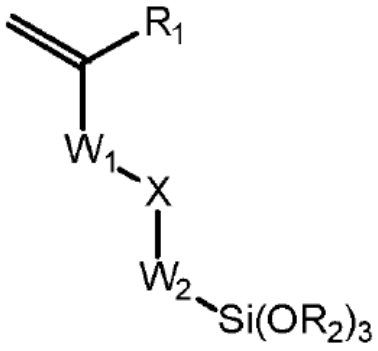
a polymerized and crosslinked monomer, wherein the monomer includes: a least one cationic group, a polymerized group, and a silicate group; and

a polymer comprising an alcohol that is chemically bonded to the silicate group of the polymerized and crosslinked monomer.

2. The self-supported ion exchange membrane according to claim 1, wherein the polymerized group is the polymerization product of an alkenyl group.

3. The self-supported ion exchange membrane according to claim 1, wherein the silicate group is the reaction product of an alkoxysilane.

4. The self-supported ion exchange membrane according to claim 1, wherein the polymerized and crosslinked monomer is the reaction product from the polymerization of a compound of formula (I):



(I)

wherein:

W_1 and W_2, independently, are a bond, or an oxygen atom, a functionalized amine group, an unfunctionalized amine group, a functionalized amide group, an unfunctionalized amide group, a carbonyl group, a functionalized hydrocarbon, an unfunctionalized hydrocarbon, or any combination thereof;

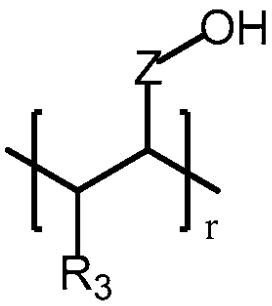
X is a cationic group, or a hydrocarbon functionalized with a cationic group;

R_1 is hydrogen, or a hydrocarbon; and

R_2 is an alkyl group.

5. The self-supported ion exchange membrane according to claim 4, wherein the chemical bond between the polymer and the polymerized and crosslinked monomer is formed from the reaction between the alkoxysilane and an alcohol on the polymer.

6. The self-supported ion exchange membrane according to claim 5, wherein the polymer comprising an alcohol that is chemically bonded to the silicate group is the reaction product from the reaction between the alkoxysilane and a compound of formula (II):



(II)

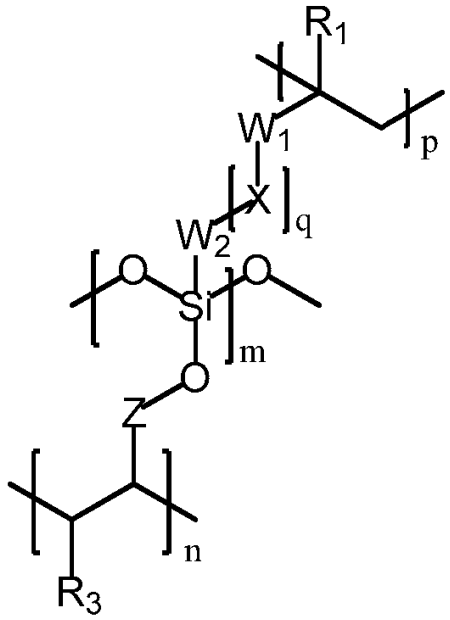
wherein:

R_3 is hydrogen, or a hydrocarbon;

Z is a bond or a hydrocarbon; and

r is an integer from about 1800 to about 4500.

7. The self-supported ion exchange membrane according to claim 1, wherein the polymerized and crosslinked monomer chemically bonded to the polymer has a structure of formula (IV):



(IV)

wherein:

W_1 and W_2, independently, are a bond, or an oxygen atom, a functionalized amine group, an unfunctionalized amine group, a functionalized amide group, an unfunctionalized amide group, a carbonyl group, a functionalized hydrocarbon, an unfunctionalized hydrocarbon, or any combination thereof;

X is a cationic group, or a hydrocarbon functionalized with a cationic group;

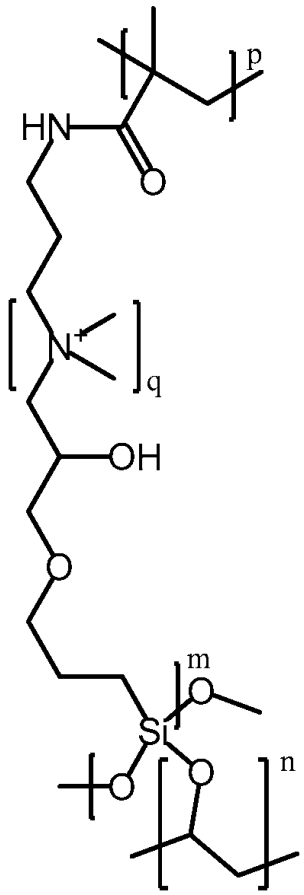
R_1 is hydrogen, or a hydrocarbon;

R_3 is a hydrogen, or a hydrocarbon;

the ratio of m : p : q is 0.1-1.5 : 0.8-1.2 : 0.8-1.2; and

the ratio of m : n is from 1 : 2.3 to 1 : 4.

8. The self-supported ion exchange membrane according to claim 7, wherein the polymerized and crosslinked monomer chemically bonded to the polymer has a structure of formula (VII):



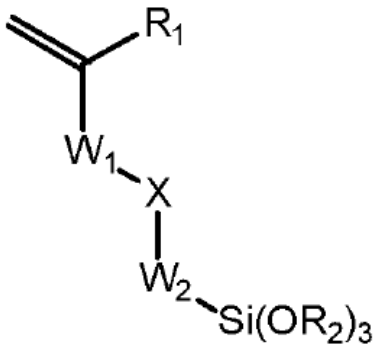
(VII).

9. A method for making a self-supported ion exchange membrane, the method comprising:

polymerizing a crosslinking monomer that includes: at least one cationic group, a polymerizable group, and a silicate forming group, to form a crosslinked polymer, wherein the polymerizing results in polymerization of the polymerizable groups and in formation of silicate from the silicate forming groups; and

reacting the crosslinked polymer with a reactive polymer that includes a plurality of silicate reactive groups that are reactive with the silicate group of the crosslinking monomer, wherein reacting the crosslinked polymer with the reactive polymer results in forming chemical bonds between the silicate and the silicate reactive groups.

10. The method according to claim 9, wherein the crosslinking monomer has a structure of formula (I):



(I)

wherein:

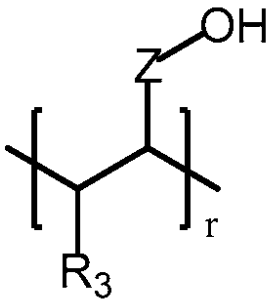
W_1 and W_2, independently, are a bond, or an oxygen atom, a functionalized amine group, an unfunctionalized amine group, a functionalized amide group, an unfunctionalized amide group, a carbonyl group, a functionalized hydrocarbon, an unfunctionalized hydrocarbon, or any combination thereof;

X is a cationic group, or a hydrocarbon functionalized with a cationic group;

R_1 is hydrogen, or a hydrocarbon; and

R_2 is an alkyl group.

11. The method according to claim 9, wherein the reactive polymer that includes a plurality of silicate reactive groups has a structure of formula (II):



(II)

wherein:

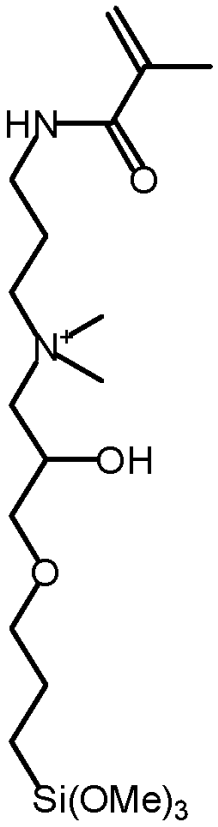
R_3 is hydrogen, or a hydrocarbon;

Z is a bond or a hydrocarbon; and

r is an integer from about 1800 to about 4500.

12. The method according to claim 9, wherein the crosslinking monomer is prepared by reacting, in the presence of an acid, a compound that includes an epoxide and the silicate forming group, with a compound that includes a tertiary amine and the polymerizable group.

13. The method according to claim 9, wherein the crosslinking monomer has a structure of formula (III):



(III).

14. The method according to claim 9, wherein the reactive polymer is polyvinyl alcohol.

15. The method according to claim 9, wherein the crosslinked polymer and the reactive polymer are reacted in a molar ratio from about 1 : 2.3 to about 1 : 4 silicate forming groups : silicate reactive groups.

16. The method according to claim 9 wherein the polymerization is a radical polymerization, which is optionally catalyzed by the addition of a heat activated radical initiator.

17. The method according to claim 9, wherein the formation of silicate from the silicate forming groups is achieved by heating the crosslinked polymer to a temperature of between 60 °C and 150 °C.

18. The method according to claim 9, further comprising casting the crosslinked polymer and the reactive polymer on a substrate before reacting the crosslinked polymer with a reactive polymer.