CLAIMS

1. An anion exchange membrane comprising:
a microporous membrane support having a porous first side, a porous second side, and a continuous porous structure extending from said first side to said second side; and a crosslinked ion transferring polymer completely filling said porous structure, said polymer formed in the continuous porous structure and comprising: the polymerization product of a monomeric solution having at least one functional monomer comprising a tertiary amine, at least one crosslinking monomer and at least one quaternizing agent, and at least one polymerization initiator.

2. The anion exchange membrane of claim 1, wherein the at least one functional monomer is selected from the group consisting of vinylimidazole and vinylcarbazole.

3. The anion exchange membrane of claim 1 , wherein the at least one crosslinking monomer is selected from the group consisting of divinylbenzene, ethylene glycol dimethacrylate, vinylbenzyl chloride, dichloroethane, propylene glycol dimethacrylate, isobutylene glycol dimethacrylate,
Octa-vinyl POSS® (OL1160) ($C_{16}H_{24}O_{12}Si_8$), Octavinyldimethylsilyi POSS® (OL1163) ($C_{32}H_{72}O_{20}Si_{16}$), Vinyl POSS® Mixture (OL1170) $((CH_2CH)_n(SiO_{1.5})_n$ wherein n= 8, 10, or 12), Trisilabolethyl POSS® (S01444) ($C_{14}H_{38}O_{12}Si_7$), Trisilanolisobutyl POSS® (SO1450) ($C_{28}H_{66}O_{12}Si_7$), Trisilanolisooctyl POSS® (S01455) ($C_{56}H_{122}O_{12}Si_7$), Octasilane POSS® (SH1310) ($C_{16}H_{56}O_{20}Si_{16}$), Octahydro POSS® (SH1311) ($H_8O_{12}Si_8$), epoxycyclohexyl-POSS® cage mixture (EP0408) $((C_8H_{13}O)_n(SiO_{1.5})_n$ wherein n= 8, 10, 12), glycidyl-POSS® cage Mixture (EP0409) $((C_6H_{11}O_2)_n(SiO_{1.5})_n$ wherein n= 8, 10, or 12), methacryl POSS® Cage Mixture (MA0735) $((C_7H_{11}O_2)_n(SiO_{1.5})_n$ wherein n= 8, 10, or 12), or Acrylo POSS® Cage Mixture (MA0736) $((C_6H_9O_2)_n(SiO_{1.5})_n$ wherein n= 8, 10, or 12).

4. The anion exchange membrane of claim 1, wherein the at least one quaternizing agent is selected from the group consisting of benzyl chloride, benzyl bromide, vinyl benzyl chloride, dichloroethane, or methyl iodide.

5. The anion exchange membrane of Claim 1 , wherein the at least one polymerization initiator is selected from the group consisting of organic peroxides,

2,2' azobis[2,[2-imdazolin-2-yl]- propane] dihydrochloride, [alpha],[alpha]'-azoisobutyronitrile, 2,2'-azobis[2- methylpropioaminidine] dihydrochloride , 2 , 2 ' azobis [2 , [2 -imdazolin-2 -yl] - propane], or dimethyl2,2'azobis[2-methylpropionate].

6. The anion exchange membrane of Claim 5 wherein the organic peroxide is benzoyl peroxide.

7. The anion exchange membrane of claim 1 wherein the monomeric solution further comprises at least one polymerization inhibitor.

8. The anion exchange membrane of claim 7, wherein the at least one polymerization inhibitor is selected from the group consisting of 4- methoxyphenol and 4-tert-butyl catechol.

9. The anion exchange membrane of claim 1 wherein the microporous support comprises polypropylene, high molecular weight polyethylene, ultrahigh molecular weight polyethylene or polyvinylidene fluoride.

10. The anion exchange membrane of claim 1 wherein a thickness of the microporous porous support is greater than 55 microns and less than 155 microns.

11. The anion exchange membrane of claim 1 wherein a thickness of the microporous porous support is greater than 20 microns and less than 55 microns.

12. A process for producing an ion exchange membrane comprising:
choosing a porous substrate having a porous first side, a porous second side, and a continuous porous structure extending from the first side to the second side;
saturating the porous substrate with a monomeric solution comprising at least one functional monomer comprising a tertiary amine, at least one crosslinking monomer, at least one quaternizing agent, and at least one polymerization initiator;
removing excess solution from the substrate while leaving the continuous porous structure filled with solution, and
initiating polymerization to form a crosslinked anion exchange polymer in the continuous porous structure of the substrate.

13. The process of Claim 12, wherein the at least one functional monomer is selected from the group consisting of vinylimidazole and vinylcarbazole.

14. The process of Claim 12, wherein the at least one crosslinking monomer is selected from the group consisting of divinylbenzene, vinylbenzyl chloride, dichloroethane, an octaglycidyl-polyhedral oligomeric silsequioxane or ethylene glycol dimethacrylate.

15. The process of Claim 12, wherein the at least one quaternizing agent is selected from the group consisting of benzyl chloride, vinyl benzyl chloride, dichloroethane, or methyl iodide.

16. The process of Claim 12, wherein the at least one polymerization initiator is selected from the group consisting of organic peroxides, 2,2'-azobis[2,(2-imidazolin-2-yl)- propane] dihydrochloride, a,a'- azoisobutyronitrile , 2,2 ' -azobis (2-methylpropioaminidine) dihydrochloride, 2,2'-azobis[2,(2-imidazolin-2-yl)-propane], and dimethyl 2 , 2 ' -azobis (2 -methylpropionate).

17. The process of Claim 16, wherein the organic peroxide is benzoyl peroxide

18. The process of Claim 12, wherein the monomeric solution further comprises at least one polymerization inhibitor.

19. The process of Claim 18, wherein the at least one polymerization inhibitor is selected from the group consisting of 4-methoxyphenol and 4-tert-butyl catechol.

20. The process of Claim 12 wherein the microporous support comprises polypropylene, high molecular weight polyethylene, ultrahigh molecular weight polyethylene or polyvinylidene fluoride.

21. The process of Claim 12 wherein a thickness of the microporous porous support is greater than 55 microns and less than 155 microns.

22. The process of Claim 12 wherein a thickness of the microporous porous support is greater than 20 microns and less than 55 microns.

CLAIMS

1. An anion exchange membrane comprising:
a microporous membrane support wherein the thickness of the microporous porous support is greater than 20 microns and less than 55 microns, said microporous support having a porous first side, a porous second side, and a continuous porous structure extending from said first side to said second side; and
a crosslinked ion transferring polymer completely filling said porous structure, said polymer formed in the continuous porous structure and comprising:
the polymerization product of a monomeric solution having at least one functional monomer comprising a tertiary amine, at least one crosslinking monomer and at least one quaternizing agent, and at least one polymerization initiator; wherein the at least one functional monomer is selected from the group consisting of vinylimidazole and vinylcarbazole.

2. The anion exchange membrane of claim 1 , wherein the at least one crosslinking monomer is selected from the group consisting of divinylbenzene, ethylene glycol dimethacrylate, vinylbenzyl chloride, dichloroethane, propylene glycol dimethacrylate, isobutylene glycol dimethacrylate,
Octa-vinyl POSS®(OL1160) ($C_{16}H_{24}O_{12}Si_8$), Octavinyldimethylsilyi POSS® (OL1163) $C_{32}H_{72}O_{20}Si_{16}$),
Vinyl POSS® Mixture (OL1170) $((CH_2CH)_n(SiO_{1.5})_n$ wherein n= 8, 10, or 12),
Trisilabolethyl POSS® (S01444) ($C_{14}H_{38}O_{12}Si_7$), Trisilanolisobutyl POSS® (SO1450) ($C_{28}H_{66}O_{12}Si_7$),
Trisilanolisooctyl POSS® (S01455) $C_{56}H_{122}O_{12}Si_7$), Octasilane POSS® (SH1310) ($C_{16}H_{56}O_{20}Si_{16}$),
Octahydro POSS® (SH1311) ($H_8O_{12}Si_8$), epoxycyclohexyl-POSS®cage mixture (EP0408) $((C_8H_{13}O)_n(SiO_{1.5})_n$ wherein n= 8, 10, 12), glycidyl-POSS®cage Mixture (EP0409) $)(C_6H_{11}O_2)_n(SiO_{1.5})_n$ wherein n= 8, 10, or 12), methacryl POSS® Cage Mixture (MA0735) $((C_7H_{11}O_2)_n(SiO_{1.5})_n$ wherein n= 8, 10, or 12), or Acrylo POSS® Cage Mixture (MA0736) $((C_6H_9O_2)_n(SiO_{1.5})_n$ wherein n= 8, 10, or 12).

3. The anion exchange membrane of claim 1, wherein the at least one quaternizing agent is selected from the group consisting of benzyl chloride, benzyl bromide, vinyl benzyl chloride, dichloroethane, or methyl iodide.

4. The anion exchange membrane of Claim 1 , wherein the at least one polymerization initiator is selected from the group consisting of organic peroxides, 2,2' azobis[2,[2-imdazolin-2-yl]- propane] dihydrochloride, [alpha],[alpha]'-azoisobutyronitrile, 2,2'-azobis[2- methylpropioaminidine] dihydrochloride , 2 , 2 ' azobis [2 , [2 -imdazolin-2 -yl] - propane], or dimethyl2,2'azobis[2-methylpropionate].

5. The anion exchange membrane of Claim 4 wherein the organic peroxide is benzoyl peroxide.

6. The anion exchange membrane of claim 1 wherein the monomeric solution further comprises at least one polymerization inhibitor.

7. The anion exchange membrane of claim 6, wherein the at least one polymerization inhibitor is selected from the group consisting of 4- methoxyphenol and 4-tert-butyl catechol.

8. The anion exchange membrane of claim 1 wherein the microporous support comprises polypropylene, high molecular weight polyethylene, ultrahigh molecular weight polyethylene or polyvinylidene fluoride.

9. A process for producing an ion exchange membrane comprising:
choosing a porous substrate having a porous first side, a porous second side, and a continuous porous structure extending from the first side to the second side;
saturating the porous substrate with a monomeric solution comprising at least one functional monomer comprising a tertiary amine, at least one crosslinking monomer, at least one quaternizing agent, and at least one polymerization initiator; wherein the at least one functional monomer is selected from the group consisting of vinylimidazole and vinylcarbazole;
removing excess solution from the substrate while leaving the continuous porous structure filled with solution, and
initiating polymerization to form a crosslinked anion exchange polymer in the continuous porous structure of the substrate wherein the thickness of the microporous porous support is greater than 20 microns and less than 55 microns.

10. The process of Claim 9, wherein the at least one crosslinking monomer is selected from the group consisting of divinylbenzene, vinylbenzyl chloride, dichloroethane, an octaglycidyl-polyhedral oligomeric silsequioxane or ethylene glycol dimethacrylate.

11. The process of Claim 9, wherein the at least one quaternizing agent is selected from the group consisting of benzyl chloride, vinyl benzyl chloride, dichloroethane, or methyl iodide.

12. The process of Claim 9, wherein the at least one polymerization initiator is selected from the group consisting of organic peroxides, 2,2'-azobis[2,(2-imidazolin-2-yl)- propane] dihydrochloride, a,a'- azoisobutyronitrile , 2,2 ' -azobis (2-methylpropioaminidine) dihydrochloride, 2,2'-azobis[2,(2-imidazolin-2-yl)-propane], and dimethyl 2 , 2 ' -azobis (2 -methylpropionate).

13. The process of Claim 12, wherein the organic peroxide is benzoyl peroxide.

14. The process of Claim 9, wherein the monomeric solution further comprises at least one polymerization inhibitor.

15. The process of Claim 14, wherein the at least one polymerization inhibitor is selected from the group consisting of 4-methoxyphenol and 4-tert-butyl catechol.

16. The process of Claim 9 wherein the microporous support comprises polypropylene, high molecular weight polyethylene, ultrahigh molecular weight polyethylene or polyvinylidene fluoride.