CLAIMS

1. A method of producing an ion exchange membrane support, comprising:

saturating a polymeric microporous substrate having a thickness between 25 μm and 55 μm with a charged monomer solution comprising at least one functional monomer, a cross-linking agent, and an effective amount of at least one photopolymerization initiator; and

polymerizing the at least one functional monomer by exposing the saturated polymeric microporous substrate to ultraviolet light in a substantially oxygen free environment at room temperature for an amount of time effective to cross-link the at least one functional monomer and produce the ion exchange membrane support, and

controlling temperature during the polymerization by pulsating the ultraviolet light to maintain a temperature less than 30ºC.

2. The method of claim 1, wherein the at least one photopolymerization initiator comprises at least one of 1-hydroxy-cyclohexyl phenyl ketone, phenyl bis(2,4,6-trimethylbenzoyl) phosphine oxide, bis-acylphosphinoxide, 2-hydroxy-2-methylpropiophenone, 2,2'-azobisisobutyronitrile, and 2,2-dimethoxy-2-phenyl-acetophene.

3. The method of claim 2, wherein the effective amount is between about 2% w/w and 5% w/w.

4. The method of claim 2, wherein the effective amount is about 2% w/w and the amount of time effective to cross-link the at least one functional monomer is between about 20 seconds and about 30 seconds.

5. The method of claim 1, comprising producing a cation exchange membrane support, wherein the at least one functional monomer comprises at least one of 2-sulfoethylmethacrylate (2-SEM), 2-acrylamide-2-methyl propane sulfonic acid (AMPS), sulfonated glycidylmethacrylate, 3-sulfopropyl methacrylate, sodium 1-allyloxy-2 hydroxypropyl sulfonate, acrylic and methacrylic acid or their salts, sodium styrene sulfonate, styrene sulfonic acid, sulfonated vinylbenzyl chloride sodium 1-allyloxy-2 hydroxypropyl sulfonate, 4-Vinylbenzoic acid, Trichloroacrylic acid, vinyl phosphoric acid, and vinyl sulfonic acid.

6. The method of claim 1, further comprising functionalizing an exterior surface of the ion exchange membrane support with a charged compound layer, drying the functionalized ion exchange membrane support, and soaking the functionalized ion exchange membrane support in a solution comprising an acid or a base for an amount of time effective to produce a monovalent selective ion exchange membrane.

7. The method of claim 1, wherein the ion exchange membrane has a permselectivity of at least 90% and a resistance of less than 2 Ω-cm^2.

8. The method of claim 1, wherein the cross-linking agent comprises at least one of divinyl benzene (DVB) and ethylene glycol dimethacrylate (EGDM).

9. A method of producing an ion exchange membrane support, comprising:

saturating a polymeric microporous substrate with a charged monomer solution comprising at least one functional monomer, a cross-linking agent, and an effective amount of at least one photopolymerization initiator, the charged monomer solution being formulated to produce a substantially transparent saturated polymeric microporous substrate; and

polymerizing the at least one functional monomer by exposing the saturated polymeric microporous substrate to ultraviolet light having a wavelength effective to photoinitiate the at least one photopolymerization initiator, in a substantially oxygen free environment at an intensity effective to penetrate the substrate and for an amount of time effective to cross-link the at least one functional monomer and produce the ion exchange membrane support, , and

controlling temperature during the polymerization by pulsating the ultraviolet light to maintain a temperature less than 30ºC.

10. The method of claim 9, comprising exposing the saturated polymeric microporous substrate to ultraviolet light having an intensity between about 2000 mW/cm^2 and about 2200 mW/cm^2 for an amount of time between about 1 second and about 5 seconds.

11. The method of claim 9, comprising exposing the saturated polymeric microporous substrate to ultraviolet light having an intensity between about 200 mW/cm^2 and about 500 mW/cm^2 for an amount of time between about 20 seconds and about 30 seconds.

12. The method of claim 9, comprising exposing the saturated polymeric microporous substrate to ultraviolet light having an intensity between about 500 mW/cm^2 and about 2000 mW/cm^2 for an amount of time between about 5 seconds and about 20 seconds.

13. The method of claim 9, comprising exposing the saturated polymeric microporous substrate to ultraviolet light on a top and bottom surface.

14. The method of claim 13, comprising exposing the saturated polymeric microporous substrate to ultraviolet light having an intensity between about 200 mW/cm^2 and about 500 mW/cm^2 on each of the top and bottom surface.

15. The method of claim 9, wherein the polymerization is performed at room temperature, the method comprising pulsating the ultraviolet light to maintain a temperature less than 30ºC.

16. The method of claim 9, comprising exposing the saturated polymeric microporous substrate to ultraviolet light having an intensity between about 2000 mW/cm^2 and about 2200 mW/cm^2.

17. The method of claim 9, wherein the at least one photopolymerization initiator comprises at least one of 1-hydroxy-cyclohexyl phenyl ketone, phenyl bis(2,4,6-trimethylbenzoyl) phosphine oxide, bis-acylphosphinoxide, 2-hydroxy-2-methylpropiophenone, 2,2'-azobisisobutyronitrile, and 2,2-dimethoxy-2-phenyl-acetophene.

18. The method of claim 9, wherein the wavelength effective to photoinitiate the at least one photopolymerization initiator is between about 245 nm and about 420 nm.

19. The method of claim 17, wherein the charged monomer solution comprises at least two photopolymerization initiators, and at least two of the photopolymerization initiators are configured to photoinitiate at different wavelengths.

20. The method of claim 19, wherein the method comprises exposing the saturated polymeric microporous substrate to a first ultraviolet light having a first wavelength effective

to photoinitiate a first photopolymerization initiator and a second ultraviolet light having a second wavelength effective to photoinitiate a second photopolymerization initiator.

21. A method of producing a monovalent selective ion exchange membrane, comprising:

saturating a polymeric microporous substrate having a thickness between 25 μm and 55 μm with a charged monomer solution comprising at least one functional monomer, a cross-linking agent, and an effective amount of at least one photopolymerization initiator;

polymerizing the at least one functional monomer by exposing the saturated polymeric microporous substrate to ultraviolet light in a substantially oxygen free environment at room temperature for an amount of time effective to cross-link the at least one functional monomer and produce an ion exchange membrane support;

controlling temperature during the polymerization by pulsating the ultraviolet light to maintain a temperature less than 30ºC;

functionalizing an exterior surface of the ion exchange membrane support with a charged compound layer;

drying the functionalized ion exchange membrane support; and

soaking the functionalized ion exchange membrane support in a solution comprising an acid or a base for an amount of time effective to produce the monovalent selective ion exchange membrane.

22. The method of claim 21, comprising soaking the functionalized ion exchange membrane support in a solution comprising 1N NaOH for about 15 minutes.

23. The method of claim 21, further comprising rinsing the monovalent selective ion exchange membrane with water and conditioning the monovalent selective ion exchange membrane in a solution comprising 0.5M NaCl.

24. The method of claim 1, wherein pulsating the ultraviolet light comprises pulsating the ultraviolet light upon detection of a temperature above 30ºC and applying the ultraviolet light continuously upon detection of a temperature below 30ºC.

25. The method of claim 9, wherein pulsating the ultraviolet light comprises pulsating the ultraviolet light upon detection of a temperature above 30ºC and applying the ultraviolet light continuously upon detection of a temperature below 30ºC.

26. The method of claim 20, wherein the first wavelength is between 245 nm and 300 nm and the second wavelength is between 300 nm and 420 nm.

27. The method of claim 1, wherein the charged monomer solution comprises at least two photopolymerization initiators, the method comprising exposing the saturated polymeric microporous substrate to a first ultraviolet light having a first wavelength between 245 nm and 300 nm effective to photoinitiate a first photopolymerization initiator and a second ultraviolet light having a second wavelength between 300 nm and 420 nm effective to photoinitiate a second photopolymerization initiator.