CLAIMS

1. An ion exchange membrane, comprising:

a polymeric microporous substrate; and

a cross-linked ion transferring polymeric layer on the substrate, the cross-linked ion transferring polymeric layer comprising a polymerization product of at least a functional monomer and a low value r_2/r_s monomer.

2. The ion exchange membrane of claim 1, wherein the low value r2/rs monomer is a cross-linking monomer.

3. The ion exchange membrane of claim 1, wherein the cross-linked ion transferring polymeric layer comprises the polymerization product of at least the functional monomer, a cross-linking monomer, and the low value r2/rs monomer.

4. The ion exchange membrane of claim 1, wherein the thickness of the polymeric microporous substrate is between about 20 microns and about 255 microns.

5. The ion exchange membrane of claim 1, wherein the cross-linked ion transferring polymeric layer comprises a cross-linked cation transferring polymer.

6. The ion exchange membrane of claim 5, wherein the cross-linked cation transferring polymer is formed by the polymerization of 2-sulfoethylmacrylate and a cross-linking monomer.

7. The ion exchange membrane of claim 6, wherein the cross-linking monomer is selected from the group consisting of ethyleneglycol-dimethacrylate, m-divinylbenzene, p-divinylbenzene and mixtures thereof.

8. The ion exchange membrane of claim 5, wherein the cross-linked cation transferring polymer is formed by the polymerization of 2-sulfoethylmacrylate, a low value r_2/r_s monomer and a cross-linking monomer.

9. The ion exchange membrane of claim 8, wherein the low value r_2/r_s monomer has an r_2/r_s value of less than about 1.3.

10. The ion exchange membrane of claim 8, wherein the low r_2/r_s monomer is selected from the group consisting of acrylic acid and methacrylic acid, glycidylmethacrylate, and methylmethacrylate.

11. The ion exchange membrane of claim 8, wherein the cross-linking monomer comprises at least one of ethyleneglycol- dimethacrylate, m-divinylbenzene, and a mixture of m-divinylbenzene and p-divinylbenezene.

12. The ion exchange membrane of claim 1, wherein the polymeric microporous substrate comprises polypropylene, high molecular weight polyethylene, ultrahigh molecular weight polyethylene, polyvinyl chloride, or polyvinylidene fluoride.

13. The ion exchange membrane of claim 5, wherein the membrane has an apparent permselectivity of at least about 95%.

14. The ion exchange membrane of claim 5, wherein the membrane resistivity is less than about 1.5 Ohm-cm^2.

15. The ion exchange membrane of claim 5, wherein the ion transferring polymeric layer comprises a cross-linked anion transferring polymer.

16. The ion exchange membrane of claim 15, wherein the cross-linked anion transferring polymer comprises the polymerization product of:

at least one of 1-vinylimidazole, 2-methyl-1-vinylimidazole, N-vinylcarbazole, 2-vinylpyridine, or 3-vinylpyridine;

a cross-linking monomer comprising at least one of m-divinylbenzene, p-divinylbenzene , or chloromethyl styrene (vinylbenzyl chloride); and

a quaternization agent comprising at least one of benzyl chloride, benzyl bromide, methyl iodide, or butyl chloride.

17. The ion exchange membrane of claim 16, wherein the cross-linked anion transferring polymer is the polymerization product of 1-vinylimidazole, vinylbenzyl chloride and/or divinylbenzene.

18. The ion exchange membrane of claim 16, wherein the quaternization agent is benzyl chloride.

19. The ion exchange membrane of claim 16, wherein the membrane has a permselectivity of at least about 88%.

20. The ion exchange membrane of claim 15, wherein the membrane has a resistivity less than about 1.5 Ohm-cm^2.

21. An ion exchange membrane, comprising the polymerization product of a first monomer having a reactivity ratio r_1 and a second monomer having a reactivity ratio r_2 wherein the reactivity ratio product of the first monomer and the second monomer is less than about 0.3 or between about 0.9 and1.1.

22. A water treatment system, comprising:

an electrochemical separation device including at least one ion exchange membrane of claim 1.

23. A method of making an ion exchange membrane, comprising:

mixing a solution including at least a functional monomer and a low value r_2/r_s monomer, wherein at least two of the monomers have a styrene-normalized reactivity ratio product $[(r_2/r_s)_1 \times (r_2/r_s)_2]$ of less than about 0.6 or between about 0.7 to 1.3;

saturating a polymeric microporous substrate with the solution; and

polymerizing the solution on the saturated substrate to form the ion exchange membrane.

CLAIMS

1. An invention not claimed in any divisional application.