Claims

1. A method of forming a cross-linked polymeric membrane, the method comprising contacting a polymeric membrane with a cross-linking solution to form the cross-linked polymeric membrane, wherein the cross-linking solution comprises a cross-linker comprising at least one acyl halide functional group dissolved in a polar protic solvent comprising an alcohol, wherein the alcohol is not a tertiary alcohol, and wherein the cross-linked polymeric membrane has a polymer gel content of ≥ 95% after polymer dissolution, wherein the polymer gel content is calculated using the formula: $\%\ polymer\ gel\ content = \frac{final\ fibre\ weight}{initial\ fibre\ weight} \times 100\%$.

2. The method according to claim 1, wherein the polymeric membrane is formed from a polymer comprising at least one imidazole group.

3. The method according to claim 2, wherein the polymer is: polybenzimidazole (PBI).

4. The method according to any preceding claim, wherein the at least one acyl halide functional group comprised in the cross-linker is an acyl chloride functional group.

5. The method according to any preceding claim, wherein the cross-linker comprises at least two or three acyl halide functional groups.

6. The method according to claim 5, wherein the cross-linker is: trimesoyl chloride (TMC), isophthaloyl chloride (IPC), terephthaloyl chloride or a combination thereof.

7. The method according to any preceding claim, wherein the polar protic solvent comprises at least one alcohol selected from: methanol, ethanol, and isopropyl alcohol (IPA).

8. The method according to any preceding claim, wherein the contacting is for a pre-determined period of time and at a pre-determined temperature.

9. The method according to claim 8, wherein the pre-determined temperature is 5-100°C.

10. The method according to claim 8, wherein the pre-determined period of time is 1 minute to 120 hours.

11. The method according to any preceding claim, wherein the polymeric membrane is a flat-sheet membrane, a hollow fibre membrane, tubular membrane, or a dense membrane.

12. The method according to any preceding claim, wherein the cross-linking solution comprises 0.01-20 % (weight/weight) of the cross-linker.

13. The method according to any preceding claim, wherein the method further comprises performing solvent exchange on the polymeric membrane prior to the contacting.

14. The method according to claim 13, wherein the performing solvent exchange comprises performing solvent exchange with the polar protic solvent comprised in the cross-linking solution.

15. The method according to any preceding claim, wherein the cross-linked polymeric membrane has a thickness of 1-1000 μm.

16. The method according to any preceding claim, wherein the cross-linked polymeric membrane is hydrophilic.

17. A cross-linked polymeric membrane comprising a polymeric membrane cross-linked by a cross-linker comprising at least one acyl halide functional group, wherein the cross-linked polymeric membrane has a polymer gel content of ≥ 95% after polymer dissolution, wherein the polymer gel content is calculated using the formula: $\%\ polymer\ gel\ content = \frac{final\ fibre\ weight}{initial\ fibre\ weight} \times 100\%$.

18. The cross-linked polymeric membrane according to claim 17, wherein the polymeric membrane is formed from a polymer comprising at least one imidazole group.

19. The cross-linked polymeric membrane according to claim 18, wherein the polymer is: polybenzimidazole (PBI).

20. The cross-linked polymeric membrane according to any of claims 17 to 19, wherein the at least one acyl halide functional group comprised in the cross-linker is an acyl chloride functional group.

21. The cross-linked polymeric membrane according to any of claims 17 to 20, wherein the cross-linker comprises at least two or three acyl halide functional groups.

22. The cross-linked polymeric membrane according to any of claims 17 to 21, wherein the cross-linker is: trimesoyl chloride (TMC), isophthaloyl chloride (IPC), terephthaloyl chloride or a combination thereof.

23. The cross-linked polymeric membrane according to any of claims 17 to 22, wherein the polymeric membrane is a flat-sheet membrane, a hollow fibre membrane, tubular membrane, or a dense membrane.

24. The cross-linked polymeric membrane according to any of claims 17 to 23, wherein the cross-linked polymeric membrane is hydrophilic.