CLAIMS

1. A reinforced flat sheet membrane operable to withstand vacuum pressure and a high pressure of up to 1500 psi, wherein the reinforced flat sheet membrane comprises:

a polymeric membrane;

a permeate carrier which reinforces the polymeric membrane and has channels to direct permeate flow;

wherein the polymeric membrane has the permeate carrier incorporated therein and the channels of the permeate carrier are partially exposed at a surface of the polymeric membrane,

and further comprising a pre-wetting agent coated on the permeate carrier, wherein the pre-wetting agent comprises a constituent different from the polymeric membrane, wherein the pre-wetting agent comprises the constituent as a liquid or as a gaseous solution, and wherein the liquid or gaseous solution contains:

an anionic surfactant, wherein the anionic surfactant comprises a detergent, a fatty acid, a foaming agent, or a dispersant; or

a non-ionic surfactant, wherein the non-ionic surfactant comprises alcohol, ester, phenol, ether, or amide; or

a cationic surfactant, wherein the cationic surfactant comprises a salt solution, wherein the salt solution comprises an organic solvent or an inorganic solvent, wherein the organic solvent comprises N-methyl-2-pyrrolidone, dimethylformamide, hexane, or a combination thereof, wherein the inorganic solvent comprises water; or

a combination thereof.

2. The reinforced flat sheet membrane of claim 1, wherein the permeate carrier comprises a mesh, wherein the mesh comprises a woven mesh, a non-woven mesh, or a tricot mesh, and wherein the mesh is formed of cellulose, polyester, polypropylene, acrylic, nylon, sulfonated polysulfone, polysulfone, polyethersuflone, polyimide, polyamide, polybenzimidazole, polyacrylonitrile, polyarylsulfone, poly(vinyl butyral), polyetherimide, a derivative thereof, or a combination thereof.

3. The reinforced flat sheet membrane of claim 2, wherein the mesh has a pore size ranging from 100 μm to 5000 μm.

4. The reinforced flat sheet membrane of any one of claims 1 to 3, wherein the polymeric membrane has a porous substrate layer which:

(i) an active rejection layer is formed on; and

(ii) the permeate carrier is incorporated in the porous substrate layer;

wherein the porous substrate layer comprises cellulose, polyester, polypropylene, acrylic, nylon, sulfonated polysulfone, polysulfone, polyethersuflone, polyimide, polyamide, polybenzimidazole, polyacrylonitrile, polyarylsulfone, poly(vinyl butyral), polyetherimide, a derivative thereof, or a combination thereof.

5. The reinforced flat sheet membrane of claim 4, wherein the active rejection layer comprises polyamide, polyamine, polyamide-imide, polyhydric alcohol, polyphenol, a derivative thereof, or a combination thereof.

6. The reinforced flat sheet membrane of any one of claims 1 to 5, wherein the reinforced flat sheet membrane has a thickness ranging from 20 µm to 300 µm.

7. The reinforced flat sheet membrane of any one of claims 1 to 6, wherein the reinforced flat sheet membrane is operable to withstand a pressure from 1.5×10^{-11} psi to 1500 psi.

8. The reinforced flat sheet membrane of any one of claims 1 to 7, wherein the reinforced flat sheet membrane is operable for microfiltration, ultrafiltration, nanofiltration, reverse osmosis, pressure retarded osmosis, forward osmosis, pervaporation, membrane distillation, and/or gas separation.

9. A method of fabricating a reinforced flat sheet membrane operable to withstand vacuum pressure and a high pressure of up to 1500 psi, wherein the reinforced flat sheet membrane comprises:

a polymeric membrane;

a permeate carrier which reinforces the polymeric membrane and has channels to direct permeate flow;

wherein the polymeric membrane has the permeate carrier incorporated therein and the channels of the permeate carrier are partially exposed at a surface of the polymeric membrane, wherein the method comprises:

contacting the permeate carrier with a pre-wetting agent;

casting a polymer solution on the permeate carrier; and

forming the polymeric membrane from the polymer solution with the permeate carrier incorporated in the polymeric membrane,

wherein the pre-wetting agent comprises a constituent different from the polymer solution, wherein the pre-wetting agent undergoes pre-curing instantaneously upon contact with the polymer solution prior to complete curing in forming the polymeric membrane, wherein the pre-wetting agent comprises the constituent as a liquid or as a gaseous solution, and wherein the liquid or gaseous solution contains:

an anionic surfactant, wherein the anionic surfactant comprises a detergent, a fatty acid, a foaming agent, or a dispersant; or

a non-ionic surfactant, wherein the non-ionic surfactant comprises alcohol, ester, phenol, ether, or amide; or

a cationic surfactant, wherein the cationic surfactant comprises a salt solution, wherein the salt solution comprises an organic solvent or an inorganic solvent, wherein the organic solvent comprises N-methyl-2-pyrrolidone, dimethylformamide, hexane, or a combination thereof, wherein the inorganic solvent comprises water; or

a combination thereof.

10. The method of claim 9, wherein contacting the permeate carrier with the pre-wetting agent comprises dispensing the pre-wetting agent onto the permeate carrier at a flow rate of 10 mL/min to 10 L/min, wherein dispensing the pre-wetting agent onto the permeate carrier is carried out by spraying, misting, pouring, sponging, deposition from a slot die, roller-spreading, nip-roll spreading, dripping, or soaking.

11. The method of claim 9 or 10, further comprising removing excess pre-wetting agent from the permeate carrier.

12. The method of any one of claims 9 to 11, further comprising dissolving a polymer in an organic solvent to form the polymer solution for casting on the permeate carrier, wherein the organic solvent comprises 1-methyl-2-pyrrolidinone, dimethyl-acetamide, dimethyl formamide, or a combination thereof.

13. The method of claim 12, wherein the polymer in the organic solvent has a concentration ranging from 5 wt% to 50 wt%.

14. The method of any one of claims 9 to 13, wherein the polymer solution has a viscosity ranging from 100 to 100,000 cps.

15. The method of any one of claims 9 to 14, wherein forming the polymeric membrane comprises coagulating the polymer solution by phase inversion in the presence of a non-solvent.

16. The method of claim 15, wherein coagulating the polymer solution by phase inversion comprises having the polymer solution cast onto the permeate carrier, and immersing the polymer solution with the permeate carrier into the non-solvent, wherein the polymer solution and the permeate carrier are arranged to have the polymer solution face any direction in the non-solvent.

17. The method of claim 15 or 16, wherein forming the polymeric membrane comprises coagulating the polymer solution by phase inversion at a temperature ranging from -10°C to 150°C.

18. The method of any one of claims 9 to 17, further comprising subjecting the polymeric membrane to interfacial polymerization or chemical crosslinking to form an active rejection layer.