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.

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 ~~any one of~~ claim~~s 1 to~~ 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, further comprising a pre-wetting agent coated on the permeate carrier.~~

~~8~~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 x 10^{-11} psi to 1500 psi.

~~9~~8. The reinforced flat sheet membrane of any one of claims 1 to ~~8~~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.

~~10~~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, and wherein the pre-wetting agent undergoes pre-curing instantaneously upon contact with the polymer solution prior to complete curing in forming the polymeric membrane.

~~11~~10. The method of claim ~~10~~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.

~~12~~11. The method of claim ~~10~~9 or ~~11~~10, wherein the pre-wetting agent comprises the constituent as a liquid or as a gaseous solution, wherein the liquid or gaseous solution contain~~sing~~:

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.

~~13~~12. The method of any one of claims ~~10~~9 to ~~12~~11, further comprising removing excess pre-wetting agent from the permeate carrier.

~~14~~13. The method of any one of claims ~~10~~9 to ~~13~~12, 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.

~~15~~14. The method of claim ~~14~~13, wherein the polymer in the organic solvent has a concentration ranging from 5 wt% to 50 wt%.

~~16~~15. The method of any one of claims ~~10~~9 to ~~15~~14, wherein the polymer solution has a viscosity ranging from 100 to 100,000 cps.

~~17~~16. The method of any one of claims ~~10~~9 to ~~16~~15, wherein forming the polymeric membrane comprises coagulating the polymer solution by phase inversion in the presence of a non-solvent.

~~18~~17. The method of claim ~~17~~16, 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.

~~19~~18. The method of claim ~~17~~16 or ~~18~~17, wherein forming the polymeric membrane comprises coagulating the polymer solution by phase inversion at a temperature ranging from -10°C to 150°C.

~~20~~19. The method of any one of claims ~~10~~9 to ~~19~~18, further comprising subjecting the polymeric membrane to interfacial polymerization or chemical crosslinking to form an active rejection layer.