CLAIMS

1. A method of manufacturing a multilayer polymeric and mixed matrix membrane comprising:

providing a support layer;

casting a hydrophilic layer on a surface of the support layer;

casting a hydrophobic layer on the hydrophilic layer; and

allowing both hydrophilic and hydrophobic layers to form a multilayer polymeric and mixed matrix membrane via immersion into water (phase inversion method);

wherein the hydrophobic layer comprises a hydrophobic polymer selected from the group consisting of polypropylene, polytetraflouroethylene, and polyvinylidene fluoride wherein the hydrophobic layer further comprises a fluorinated hydrophobic surface modifying macro-molecule selected from a group consisting of polyurethane propylene glycol), poly(urethane diphenylsulfone), and poly(urea dimethyl-siloxane urethane), wherein the hydrophilic layer comprises a hydrophilic polymer selected from the group consisting of polysulfone, polyether sulfone, polyether-imide, polyamide, cellulose acetate, and hydrophilic thermoplastics~~.~~, and wherein the hydrophilic layer further comprises an inorganic nanoparticle having high thermal conductivity selected from the group consisting of boron nitride, aluminium nitride, silicon carbide, and copper or aluminium or iron~~)~~ or copper oxide.

2. The method according to claim 1, wherein the hydrophilic layer further comprises a non-solvent additive selected from: a group consisting of γ-butyrolactone and ethanol.

3. The method according to claim 1, further comprising a step of maximizing the porosity of the hydrophobic layer.

4. The method according to claim 1, further comprising a step of minimizing the thickness of the hydrophobic layer.

5. The method according to claim 1, further comprising a step of maximizing-the porosity of the hydrophilic layer.

6. The method according to claim 1, further comprising a step of maximizing the thickness of the hydrophilic layer.

7. The method according to claim 1, further comprising a step of maximizing the thermal conductivity of the hydrophilic layer.

8. The method according to claim 1, further comprising:

a step of using a hydrophilic polymer dope solution comprising a host hydrophilic polymer to cast the hydrophilic layer; and

a step of using a hydrophobic polymer dope solution comprising a hydrophobic polymer to cast the hydrophobic layer,

wherein the hydrophobic polymer dope solution has a lower viscosity and density-than the hydrophilic polymer dope solution on the previously cast hydrophilic film.

9. A plate-and-frame membrane module for direct contact membrane distillation using a multilayer polymeric and mixed matrix membrane formed by the method of any one of the preceding claims, the plate-and-frame membrane module comprising:

a feed inlet capable of distributing process solution throughout the membrane module;

a permeate inlet capable of distributing process solution throughout the membrane module;

a tortuous promoter comprising multiple flow channels;

a feed outlet; and

a permeate outlet.

10. The membrane module of claim 9, wherein the polymeric and matrix membrane is configured as a flat sheet membrane.

11. The membrane module of claim 9, wherein the flow regimes of feed and permeate flow solutions during direct contact membrane distillation is a turbulent regime.

12. The membrane module according to claim 9, wherein the feed and permeate flow channels are configured such that there is no liquid stagnation in the flow channels.

13. The membrane module according to claim 9, configured for direct contact membrane distillation wherein seawater desalination flux is up to 142 kg/m^2h.

14. The membrane module according to claim 9, configured for direct contact membrane

distillation such that it maximizes the Reynolds number.

15. The membrane module according to claim 9, configured for direct contact membrane distillation such that it improves flow hydrodynamics.

16. The membrane module according to claim 9, configured for direct contact membrane distillation such that it maximizes heat transfer coefficients and minimizes heat and mass resistances in boundary layers.

17. The membrane module according to claim 9, configured for direct contact membrane distillation such that it maximizes temperature polarizing coefficient until it reaches unity.

18. An array comprising multiple plate-and-frame membrane modules according to claim 9.