## Claims

1. A method of preparing a composite membrane, the method comprising:
   a) impregnating a surface of a porous membrane substrate with an aqueous suspension comprising a mixture of at least one polyamine and at least one phospholipid;
   b) contacting the impregnated surface with an organic phase containing a monomer comprising at least one crosslinking group to thereby deposit a polyamide layer on the impregnated surface, wherein the polyamide layer comprises the at least one phospholipid dispersed therein, and wherein the polyamide layer is an interfacial polymerization product.

2. The method of claim 1, wherein the monomer comprises at least two acyl halide or sulfonyl halide groups; or

   wherein the monomer comprising at least one crosslinking group is selected from the group consisting of trimesoyl chloride (1,3,5–benzenetricarbonyl trichloride), terephthalic acid chloride, isophthalic acid chloride, biphenyl dicarboxylic acid chloride, naphthalene dicarboxylic acid dichloride, biphenyl-4,4′-disulfonyl chloride , 1,3,6-naphthalenetrisulfonyl chloride and mixtures thereof; or

   wherein the polyamine is a monomer comprising at least two amine groups, wherein said amine groups are independently primary or secondary amine groups; or

   wherein the polyamine is selected from the group consisting of: m-phenylenediamine (MPD), m-phenylenediamine-4-methyl, 1,3-cyclohexanebis(methylamine), o-phenylenediamine (OPD), piperazine, p-phenylenediamine (PPD), 1,1'-biphenyl-4,4'-diamine (benzidine), polyethyleneimine, and mixtures thereof.

3. The method of claims 1 or 2, wherein excess aqueous suspension is removed via a rinsing, gas purging or blowing step prior to the contacting step b).

4. The method of any one of the preceding claims, wherein the aqueous suspension comprises the phospholipid in a molar concentration of from about 10 μM to about 10 mM; or -

~~5. The method of any one of the preceding claims, wherein the aqueous suspension comprises the phospholipid in a molar concentration of~~from 50 μM to about 4 mM; or ~~.~~

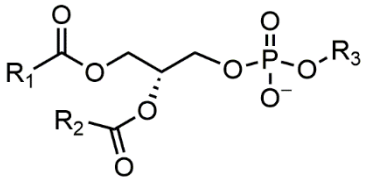
6. The method of any one of the preceding claims, wherein the aqueous suspension comprises the polyamine in a concentration of from about 0.001 wt. % to about 10 wt. ~~%.~~%; or

~~7. The method of any one of the preceding claims, wherein the aqueous suspension comprises the polyamine in a concentration of~~ from about 0.5 wt. % to about 3 wt. %.

~~8~~6. The method of any one of the preceding claims, wherein the aqueous suspension is substantially devoid of transmembrane proteins or analogues thereof; or ~~.~~

~~9. The method of claim 8,~~ wherein the aqueous suspension is substantially devoid of aquaporins.

~~10~~7. The method of any one of the preceding claims, wherein the phospholipid has a formula (I):

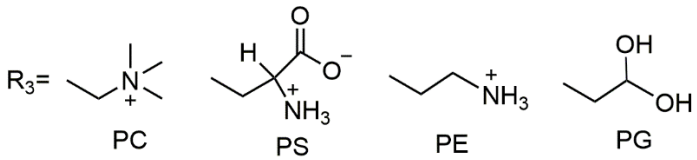


(Formula I)

wherein $R_1$ represents a saturated or an unsaturated aliphatic group having 14 to 24 carbon atoms; and

wherein $R_2$ represents a saturated or an unsaturated aliphatic group having 14 to 24 carbon atoms; and

wherein $R_3$ is:



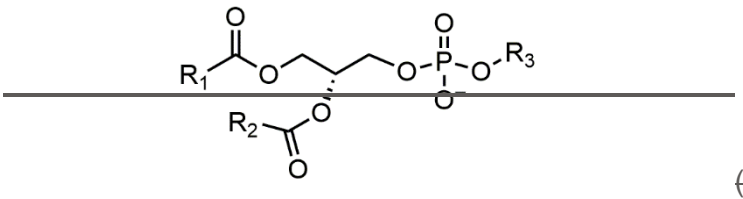

; or

wherein the phospholipid is selected from the group consisting of: 1,2-dioleoyl-sn-glycero-3-phosphocholine (DOPC), 1,2-dioleoyl-sn-glycero-3-phosphoethanolamine (DOPE), 1,2-dioleoyl-sn-glycero-3-phospho-rac-(1-glycerol) (DOPG), L-α-phosphatidylcholine (egg PC), 1,2-ditetradecanoyl-sn-glycero-3-phosphocholine (DMPC), 2-oleoyl-1-palmitoyl-sn-glycero-3-phosphocholine (POPC), 1,2-dilauroyl-sn-glycero-3-phosphocholine (DLPC), 1,2-dimyristoyl-sn-glycero-3-phosphocholine (DMPC), 1,2-dipalmitoyl-sn-glycero-3-phosphocholine (DPPC), 1,2-distearoyl-sn-glycero-3-phosphocholine (DSPC), 1,2-dilauroyl-sn-glycero-3-phospho-(1'-rac-glycerol) (sodium salt) (DLPG), 1,2-dimyristoyl-sn-glycero-3-phospho-(1'-rac-glycerol) (sodium salt) (DMPG), 1,2-dipalmitoyl-sn-glycero-3-phospho-(1'-rac-glycerol) (sodium salt) (DPPG), 1-palmitoyl-2-oleoyl-sn-glycero-3-phospho-(1'-rac-glycerol) (sodium salt) (POPG), 1,2-dimyristoyl-sn-glycero-3-phospho-L-serine (sodium salt) (DMPS), 1,2-dipalmitoyl-sn-glycero-3-phospho-L-serine (sodium salt) (DPPS), 1,2-distearoyl-sn-glycero-3-phospho-L-serine (sodium salt) (DSPS), 1,2-dioleoyl-sn-glycero-3-phospho-L-serine (sodium salt) (DOPS), 1-palmitoyl-2-oleoyl-sn-glycero-3-phospho-L-serine (sodium salt) (POPS), 1,2-dilauroyl-sn-glycero-3-phosphate (sodium salt) (DLPA), 1,2-dimyristoyl-sn-glycero-3-phosphate (sodium salt) (DMPA), 1,2-dipalmitoyl-sn-glycero-3-phosphate (sodium salt) (DPPA), 1,2-distearoyl-sn-glycero-3-phosphate (sodium salt) (DSPA), 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphate (sodium salt) (POPA), 1,2-dilauroyl-sn-glycero-3-phosphoethanolamine (DLPE), 1,2-dimyristoyl-sn-glycero-3-phosphoethanolamine (DMPE), 1,2-dipalmitoyl-sn-glycero-3-phosphoethanolamine (DPPE), 1,2-distearoyl-sn-glycero-3-phosphoethanolamine (DSPE), 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphoethanolamine (POPE), 1,2-di-O-octadecenyl-3-trimethylammonium propane (chloride salt) (DOTMA), *E.coli* lipid extract, soy lipid extract, yeast lipid extract, 1-palmitoyl-2-(dipyrromethene boron difluoride)undecanoyl-sn-glycero-3-phosphocholine, 1,2-dioleoyl-sn-glycero-3-phospho-(1'-myo-inositol) (ammonium salt) (DOPI), 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphoinositol (ammonium salt) (POPI), 1,2-dipalmitoyl-sn-glycero-3-phospho-(1'-myo-inositol) (ammonium salt) (DPPI), 1,1', 2,2'-tetraoleoyl cardiolipin (TOCL), 1,2-dioleoyl-sn-glycero-3-phosphoethanol (DOPEt), 1,2-dioleoyl-sn-glycero-3-phosphoethanol (DOPEt) (18:0 diethyl PC), or combinations thereof; or ~~.~~

~~11. The method of claim 10,~~ wherein the phospholipid is selected from the group consisting of: 1,2-Dioleoyl-sn-glycero-3-phosphocholine (DOPC), 1,2-Dioleoyl-sn-glycero-3-phosphoethanolamine (DOPE), 1,2-Dioleoyl-snglycero-3-phospho-rac-(1-glycerol) (DOPG),

L-α-phosphatidylcholine (egg PC), 1,2-ditetradecanoyl-sn-glycero-3-phosphocholine (DMPC), 2-Oleoyl-1-palmitoyl-sn-glycero-3-phosphocholine (POPC), and mixtures thereof.

12. The method of any one of the preceding claims, wherein the phospholipid has a formula (I):

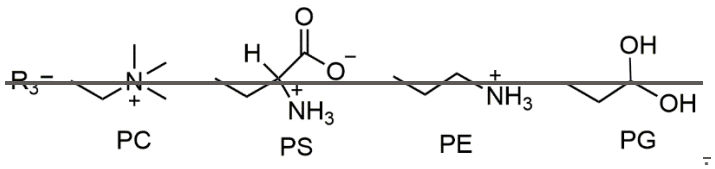


(Formula I)

wherein $R_1$ represents a saturated or an unsaturated aliphatic group having 14 to 24 carbon atoms; and

wherein $R_2$ represents a saturated or an unsaturated aliphatic group having 14 to 24 carbon atoms; and

wherein $R_3$ is:




13. The method of any one of the preceding claims, wherein the polyamine is a monomer comprising at least two amine groups, wherein said amine groups are independently primary or secondary amine groups.

14. The method of claim 13, wherein the polyamine is selected from the group consisting of: m-phenylenediamine (MPD), m-phenylenediamine-4-methyl, 1,3-cyclohexanebis(methylamine), o-phenylenediamine (OPD), piperazine, p-phenylenediamine (PPD), 1,1'-biphenyl-4,4'-diamine (benzidine), polyethyleneimine, and mixtures thereof.

15. The method of any one of the preceding claims, wherein the monomer comprising at least one crosslinking group is selected from the group consisting of trimesoyl chloride (1,3,5-benzenetricarbonyl trichloride), terephthalic acid chloride, isophthalic acid chloride, biphenyl dicarboxylic acid chloride, naphthalene dicarboxylic acid dichloride, biphenyl-4,4′-disulfonyl chloride , 1,3,6-naphthalenetrisulfonyl chloride and mixtures thereof.

~~16~~8. The method of any one of the preceding claims, wherein the organic phase comprises the monomer comprising at least one crosslinking group in a concentration of from about 0.00001 wt.% to 2 wt. %; or ~~.~~

~~17. The method of any one of the preceding claims, wherein the organic phase comprises the monomer comprising at least one crosslinking group in a concentration of~~ from about 0.001 wt.% to 1 wt.%; or

wherein the organic phase further comprises an organic solvent which is unreactive with the monomer comprising at least one crosslinking group.

~~18~~9. The method of any one of the preceding claims, wherein the contacting step (b) is undertaken for a duration sufficient to deposit the polyamide layer in a thickness of from about 50 nm to about 4,000 nm; or ~~.~~

~~19. The method of claim 18,~~ wherein the contacting step b) is undertaken for a period of about 10 s to 10 min~~.~~; or

~~20. The method of any one of the preceding claims,~~ wherein the polyamide layer is a fully-aromatic polyamide layer comprising leaf-like structures with an apparent height of 200 - 4000 nm, or wherein the polyamide layer is a semi-aromatic polyamide layer with an apparent height of less than 100 nm.

~~21. The method of any one of the preceding claims, wherein the organic phase further comprises an organic solvent which is unreactive with the monomer comprising at least one crosslinking group.~~

~~22~~10. A composite membrane comprising:

a) at least one porous membrane substrate having nano-sized or micro-sized pores, and
b) at least a polyamide layer disposed on a surface of the porous membrane substrate, the polyamide layer comprising at least one phospholipid dispersed therein, and wherein the polyamide layer is an interfacial polymerization product.

~~23~~11. The composite membrane of claim ~~22~~10, wherein the polyamide layer is formed via interfacial polymerization between two immiscible phases~~.~~; or

~~24. The composite membrane of claim 23,~~ wherein the two immiscible phases comprise an aqueous phase containing at least one polyamine and optionally, the phospholipid suspended therein; and an organic phase containing a monomer comprising at least one crosslinking group; or ~~.~~

~~25. The composite membrane of claim 24,~~ wherein the monomer comprises at least two acyl halide or sulfonyl halide groups.

~~26. The composite membrane of claim 24, wherein the aqueous phase further comprises the phospholipid suspended therein.~~

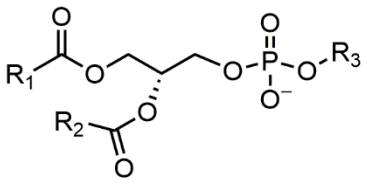
~~27~~12. The composite membrane of claim 10 or 11~~any one of claims 22 to 26~~, wherein the phospholipid is provided in a molar concentration of from about 10 μM to about 10 mM in the aqueous phase; or ~~.~~

~~28. The composite membrane any one of claims 22 to 27, wherein the aqueous suspension comprises the phospholipid in a molar concentration of~~from about 50 μM to about 4 mM.

~~29~~13. The composite membrane of any one of claims 10 to 12~~22 to 28~~, wherein the interfacial polymerization occurs on the surface of the porous membrane substrate to thereby deposit the polyamide layer thereon; or

wherein the surface of the porous membrane substrate is first impregnated with the aqueous phase comprising the polyamine and the phospholipid, prior to contacting the impregnated porous membrane substrate with the organic phase to thereby result in interfacial polymerization.

~~30~~14. The composite membrane of any one of claims 10 to 13~~22 to 29~~, wherein the phospholipid has a formula (I):

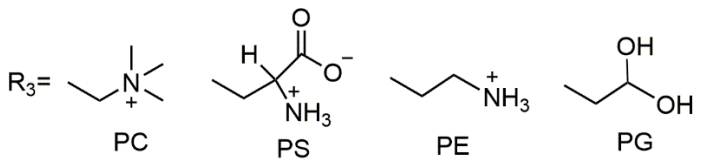


(Formula I)

wherein $R_1$ represents a saturated or an unsaturated aliphatic group having 14 to 24 carbon atoms; and

wherein $R_2$ represents a saturated or an unsaturated aliphatic group having 14 to 24 carbon atoms; and

wherein $R_3$ is:

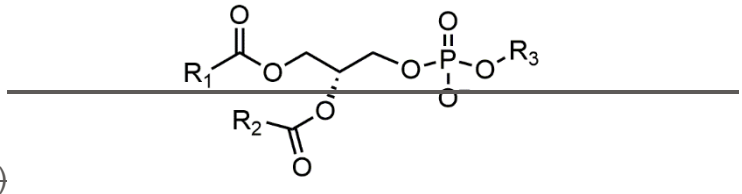



wherein the phospholipid is selected from the group consisting of: 1,2-dioleoyl-sn-glycero-3-phosphocholine (DOPC), 1,2-dioleoyl-sn-glycero-3-phosphoethanolamine (DOPE), 1,2-dioleoyl-sn-glycero-3-phospho-rac-(1-glycerol) (DOPG), L-α-phosphatidylcholine (egg PC), 1,2-ditetradecanoyl-sn-glycero-3-phosphocholine (DMPC), 2-oleoyl-1-palmitoyl-sn-glycero-3-phosphocholine (POPC), 1,2-dilauroyl-sn-glycero-3-phosphocholine (DLPC), 1,2-dimyristoyl-sn-glycero-3-phosphocholine (DMPC), 1,2-dipalmitoyl-sn-glycero-3-phosphocholine (DPPC), 1,2-distearoyl-sn-glycero-3-phosphocholine (DSPC), 1,2-dilauroyl-sn-glycero-3-phospho-(1'-rac-glycerol) (sodium salt) (DLPG), 1,2-dimyristoyl-sn-glycero-3-phospho-(1'-rac-glycerol) (sodium salt) (DMPG), 1,2-dipalmitoyl-sn-glycero-3-phospho-(1'-rac-glycerol) (sodium salt) (DPPG), 1-palmitoyl-2-oleoyl-sn-glycero-3-phospho-(1'-rac-glycerol) (sodium salt) (POPG), 1,2-dimyristoyl-sn-glycero-3-phospho-L-serine (sodium salt) (DMPS), 1,2-dipalmitoyl-sn-glycero-3-phospho-L-serine (sodium salt) (DPPS), 1,2-distearoyl-sn-glycero-3-phospho-L-serine (sodium salt) (DSPS), 1,2-dioleoyl-sn-glycero-3-phospho-L-serine (sodium salt) (DOPS), 1-palmitoyl-2-oleoyl-sn-glycero-3-phospho-L-serine (sodium salt) (POPS), 1,2-dilauroyl-sn-glycero-3-phosphate (sodium salt) (DLPA), 1,2-dimyristoyl-sn-glycero-3-phosphate (sodium salt) (DMPA), 1,2-dipalmitoyl-sn-glycero-3-phosphate (sodium salt) (DPPA), 1,2-distearoyl-sn-glycero-3-phosphate (sodium salt) (DSPA), 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphate (sodium salt) (POPA), 1,2-dilauroyl-sn-glycero-3-phosphoethanolamine (DLPE), 1,2-dimyristoyl-sn-glycero-3-phosphoethanolamine (DMPE), 1,2-dipalmitoyl-sn-glycero-3-phosphoethanolamine (DPPE), 1,2-distearoyl-sn-glycero-3-phosphoethanolamine (DSPE), 1-palmitoyl-2-oleoyl-sn-glycero-

3-phosphoethanolamine (POPE), *E.coli* lipid extract, soy lipid extract, yeast lipid extract, 1-palmitoyl-2-(dipyrromethene boron difluoride)undecanoyl-sn-glycero-3-phosphocholine, 1,2-dioleoyl-sn-glycero-3-phospho-(1'-myo-inositol) (ammonium salt) (DOPI), 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphoinositol (ammonium salt) (POPI), 1,2-dipalmitoyl-sn-glycero-3-phospho-(1'-myo-inositol) (ammonium salt) (DPPI), 1,1', 2,2'-tetraoleoyl cardiolipin (TOCL), 1,2-dioleoyl-sn-glycero-3-phosphoethanol (DOPEt), 1,2-dioleoyl-sn-glycero-3-phosphoethanol (DOPEt) (18:0 diethyl PC), or combinations thereof; or .

31. ~~The composite membrane of any one of claims 22 to 30,~~ wherein the phospholipid is selected from the group consisting of: 1,2-Dioleoyl-sn-glycero-3-phosphocholine (DOPC), 1,2-Dioleoyl-sn-glycero-3-phosphoethanolamine (DOPE), 1,2-Dioleoyl-snglycero-3-phospho-rac-(1-glycerol) (DOPG), L-α-phosphatidylcholine (egg PC), 1,2-ditetradecanoyl-sn-glycero-3-phosphocholine (DMPC), 2-Oleoyl-1-palmitoyl-sn-glycero-3-phosphocholine (POPC), and mixtures thereof.

~~32. The composite membrane of any one claims 22 to 31, wherein the phospholipid has a formula (I):~~

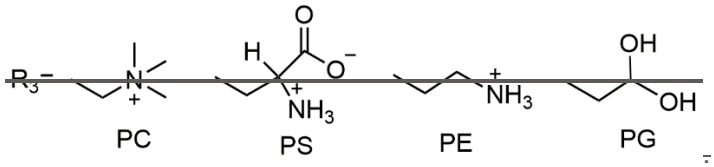


~~(Formula I)~~

~~wherein $R_1$ represents a saturated or an unsaturated aliphatic group having 14 to 24 carbon atoms; and~~

~~wherein $R_2$ represents a saturated or an unsaturated aliphatic group having 14 to 24 carbon atoms; and~~

~~wherein $R_3$ is:~~




~~33~~15. The composite membrane of any one of claims 11 to 14~~22 to 32~~, wherein the polyamine comprises at least two amine groups, wherein said amine groups are independently primary amine or secondary amine groups; or ~~.~~

34. The composite membrane of claim 33, wherein the polyamine is selected from the group consisting of: m-phenylenediamine (MPD), m-phenylenediamine-4-methyl, 1,3-cyclohexanebis(methylamine), o-phenylenediamine (OPD), piperazine, p-phenylenediamine (PPD), 1,1'-biphenyl-4,4'-diamine (benzidine), polyethyleneimine, and mixtures thereof; or .

35. The composite membrane of claim 24, wherein the monomer comprising at least one crosslinking group is selected from the group consisting of trimesoyl chloride (1,3,5–benzenetricarbonyl trichloride), terephthalic acid chloride, isophthalic acid chloride, biphenyl dicarboxylic acid chloride, naphthalene dicarboxylic acid dichloride, biphenyl-4,4′-disulfonyl chloride, 1,3,6-naphthalenetrisulfonyl chloride, and mixtures thereof.

36. The composite membrane of claim 24, wherein the organic phase further comprises an organic solvent which is unreactive with the monomer comprising at least one crosslinking group.

3716. The composite membrane of claim 2411, wherein the organic phase comprises the monomer comprising at least one crosslinking group in a concentration of from about 0.00001 wt.% to about 2 wt.%; or .

38. The composite membrane of any one of claims, wherein the organic phase comprises the monomer comprising at least one crosslinking group in a concentration of from about 0.001 wt.% to 1 wt.%; or

wherein the organic phase further comprises an organic solvent which is unreactive with the monomer comprising at least one crosslinking group.

39. The composite membrane of any one of claims 24 to 38, wherein the surface of the porous membrane substrate is first impregnated with the aqueous phase comprising the polyamine and the phospholipid, prior to contacting the impregnated porous membrane substrate with the organic phase to thereby result in interfacial polymerization.

4017. The composite membrane of any one of claims 10 to 1622 to 39, wherein the porous membrane substrate comprises polyethersulfone, polyetherimide, polysulfone,

polyacrylonitrile, polyimide, polyvinylidene fluoride, polypropylene, poly(tetrafluoroethylene), or co-polymers thereof.

~~41~~18. The composite membrane of any one of claims 10 to 17~~22 to 40~~, wherein the polyamide layer does not comprise a transmembrane protein or analogues thereof; or ~~.~~

~~42. The composite membrane of claim 41,~~ wherein the polyamide layer does not contain aquaporins.

~~43~~19. The composite membrane of any one of claims 10 to 18~~22 to 42~~, wherein the polyamide layer is a fully-aromatic polyamide layer comprising leaf-like features with an apparent height of between 200 nm to 4,000 nm, or the polyamide layer is a semi-aromatic polyamide layer with an apparent height of less than 100 nm.

~~44~~20. A hollow fiber membrane or a flat-sheet membrane comprising the composite membrane of any one of claims 10 to 19~~22 to 43~~.