Claims:

1. A porous membrane comprising:

a first layer comprising a combination of sintered inorganic particles comprising:

coarse particles having a particle size of at least 10 microns and a coarse particle sintering point, and

first fine particles having a particle size of at least 1 micron and a first fine particle sintering point below the coarse particle sintering point, and

a second layer comprising a combination of sintered inorganic particles comprising:

second fine particles having a particle size of at least 1 micron and a second fine particle sintering point below the coarse particle sintering point, and

nanoparticles having a particle size below 1 micron and a nanoparticle sintering point above the first fine particle sintering point and above the second fine particle sintering point.

2. The porous membrane of claim 1, wherein the coarse particles have a particle size in a range from 10 to 200 microns.

3. The porous membrane of claim 1, wherein:

the first fine particles have a particle size in a range from 1 to 10 microns, and

the second fine particles have a particle size in a range from 1 to 10 microns.

4. The porous membrane of claim 1, wherein the nanoparticles have a size in a range from 0.001 to 0.5 micron.

5. The porous membrane of claim 1, wherein,

the first fine particles comprise nickel or a nickel alloy,

the second fine particles comprise nickel or a nickel alloy,

the coarse particles comprise nickel or a nickel alloy, and

the nanoparticles comprise stainless steel.

6. The porous membrane of claim 5, wherein:

the first fine particle sintering point is in a range from 600 to 1100 degrees Celsius,

the second fine particle sintering point is in a range from 600 to 1100 degrees Celsius,

the coarse particle sintering point is in a range from 900 to 1200 degrees Celsius, and

the nanoparticle sintering point is in a range from 800 to 1100 degrees Celsius.

7. The porous membrane of claim 1, wherein,

the first fine particles comprise stainless steel,

the second fine particles comprise stainless steel,

the coarse particles comprise stainless steel, and

the nanoparticles comprise titanium, titanium alloy, alumina, or zirconia (ZrO_2).

8. The porous membrane of claim 7, wherein:

the first fine particle sintering point is in a range from 900 to 1200 degrees Celsius,

the second fine particle sintering point is in a range from 900 to 1200 degrees Celsius,

the coarse particle sintering point is in a range from 1000 to 1300 degrees Celsius, and

the nanoparticle sintering point is in a range from 1000 to 1400 degrees Celsius.

9. The porous membrane of claim 1, wherein the first layer comprises:

from 50 to 70 weight percent coarse particles, and

from 30 to 50 weight percent first fine particles.

10. The porous membrane of claim 1, wherein the second layer comprises:

from 40 to 75 weight percent second fine particles, and

from 25 to 60 weight percent nanoparticles.

11. The porous membrane of claim 1, comprising:

from 50 to 75 weight percent first layer, and

from 25 to 50 weight percent second layer.

12. The porous membrane of claim 1, wherein

the first fine particles are dendritic, and

the second fine particles are dendritic.

13. The porous membrane of claim 1, wherein the porous membrane comprises a tube.

14. The porous membrane of claim 13, wherein the tube has a diameter in a range from 0.5 to 2 inches.

15. The porous membrane of claim 13, wherein the porous membrane has a radial crush test value of at least 30 kilopounds per square inch, as tested according to ASTM B939-21.

16. The porous membrane of claim 1, wherein the porous membrane has a bubble point of at least 25 pounds per square inch as measured by ASTM E 128-99 (2019), measured by using 60/40 isopropyl alcohol (IPA)/water.

17. A filter assembly comprising a filter housing that contains the porous membrane of claim 1.

18. A method of processing supercritical carbon dioxide, the method comprising passing supercritical carbon dioxide through the porous membrane of claim 1.

19. A method of forming a porous membrane, the method comprising:

preparing a precursor comprising a first blend of inorganic particles comprising:

coarse particles having a particle size of at least 10 microns and a coarse particle sintering point, and

first fine particles having a particle size of at least 1 micron and a first fine particle sintering point below the coarse particle sintering point; and

applying a second blend of inorganic particles to a surface of the precursor, the second blend comprising

second fine particles having a particle size of at least 1 micron and a second fine particle sintering point below the coarse particle sintering point, and

nanoparticles having a particle size below 1 micron and a nanoparticle sintering point above the first fine particle sintering point and above the second fine particle sintering point.

20. The method of claim 19, further comprising:

compressing the first blend of inorganic particles to form a first green body,

applying the second blend of inorganic particles to the first green body,

compressing first green body and second blend of inorganic particles to form a second green body, and

sintering the second green body.

21. The method of claim 20, wherein sintering comprises increasing a temperature of the second green body such that:

the first fine particles and the second fine particles begin sintering before the coarse particles begin sintering, and

the first fine particles and the second fine particles begin sintering before the nanoparticles begin sintering.

22. The method of claim 21, wherein the coarse particles begin sintering before the nanoparticles.

23. The method of claim 20, wherein the porous membrane comprises a tube.

24. The method of claim 23, wherein tube has a diameter in a range from 0.5 to 2 inches.

25. The method of claim 23, wherein the porous membrane has a radial crush test value of at least 30 kilopounds per square inch, as tested according to ASTM B939-21.

26. The method of claim 23, the porous membrane having a bubble point of at least 25 pounds per square inch as measured by ASTM E 128-99 (2019), measured by using 60/40 isopropyl alcohol (IPA)/water.

27. A tubular porous membrane comprising:

coarse particles having a particle size of at least 10 microns,

fine particles having a particle size of at least 1 micron, and

nanoparticles having a particle size below 1 micron,

wherein the tubular porous membrane has:

a bubble point of at least 30 pounds per square inch as measured by ASTM E 128-99 (2019), measured by using 60/40 isopropyl alcohol (IPA)/water,

an air flux value of a least 0.07 slpm/cm^2 at 30 psi, and

a radial crush test value of at least 35 kilopounds per square inch measured using ASTM B939-21.

28. The tubular porous membrane of claim 27, further comprising:

a first layer comprising a combination of sintered inorganic particles comprising:

coarse particles having a particle size of at least 10 microns, and

first fine particles having a particle size of at least 1 micron, and

a second layer comprising a combination of sintered inorganic particles comprising:

second fine particles having a particle size of at least 1 micron, and

nanoparticles having a particle size below 1 micron.

29. The tubular porous membrane of claim 27, wherein the tubular porous membrane comprises a tube having a diameter in a range from 0.5 to 2 inches.