spun on a membrane. Table 1 demonstrates IPA bubble points for supporting membrane and the composites manufactured according to the examples.

[0149] Table 1. Bubble points measured for supporting 0.5 μm membrane and for membrane/nanofiber composites.

	Mean Bubble Flow Point (psi)		
	Membrane Only	Composite	% Increase
Example 2. Mycoplasma retention > 9 LRV	17	111	653
Example 4. Bacteria retention > 9 LRV	17	26	153
Example 5. Retrovirus retention > 6 LRV	17	101	594

~~[0137]~~

[0150] Example 6. Filtration throughput of a composite liquid filtration platform including a composite liquid filtration medium featuring a retrovirus-retentive nanofiber layer and a porous support membrane.

~~[0138]~~

[0151] Figure 8 depicts capacity comparisons of membrane/nanofiber composites vs. membranes spun on coarse non-woven of same nanofiber and similar retention for Mycoplasma. Throughput tests were done using a 2g/L cell culture media stream that is customarily used to test mycoplasma-retentive membranes with prefilters. This media stream contains 2 g/L Peptone from Soymeal (Papaic) available from EMD Chemicals, a subsidiary of Merck KGgA, Darmstadt, Germany; 1 g/L of Pluronic F-68; 3.7 g/L sodium bicarbonate; and 10 g/L HyClone Powdered Tissue Culture Media DMEM/High available from Thermo Scientific Waltham , MA. The porous

membrane/nanofiber composite structure has a built in prefilier layer, a porous membrane with a 0.5 μm rating (prefilter layer of Millipore Express® SHC filter, EMD Millipore Corporation, Billerica, MA), which protects the nanofiber layer from early plugging, and thus enables the composite structure to exhibits higher filtration throughput.

~~[0139]~~

[0152] Methods of use

~~[0140]~~

[0153] The composite liquid filtration platforms in accordance with the present invention are useful in the food, beverage, pharmaceuticals, biotechnology, microelectronics, chemical processing, water treatment, and other liquid treatment industries.

~~[0141]~~

[0154] The composite liquid filtration platforms as taught herein are a highly effective composite for filtering, separating, identifying, and/or detecting microorganisms from a liquid sample or liquid stream, as well as removing viruses or particulates.

~~[0142]~~

[0155] The composite liquid filtration platforms as taught herein are particularly useful in critical filtration of solutions and gases that may come into contact with or may contain pharmaceutical and biopharmaceutical compounds intended for human or animal administration.

~~[0143]~~

[0156] The composite liquid filtration platforms as taught herein may be used with any liquid sample preparation methods including, but not limited to, chromatography; high pressure liquid chromatography (HPLC); electrophoresis; gel filtration; sample centrifugation; on-line sample preparation; diagnostic kits testing; diagnostic testing; high throughput screening; affinity binding assays; purification of a liquid sample; size-based separation of the components of the fluid sample; physical properties based separation of the components of the fluid sample; chemical properties based

separation of the components of the fluid sample; biological properties based

separation of the components of the fluid sample; electrostatic properties based separation of the components of the fluid sample; and, combinations thereof.

~~[0144]~~

[0157] The composite liquid filtration platform as taught herein can be a component or part of a larger filtration device or system.

~~[0145]~~

[0158] Kits

~~[0146]~~

[0159] The composite filtration medium as taught herein can be provided as a kit, which may be used to remove microorganisms and particulates from a liquid sample or stream. The kit may comprise, for example, one or more composite filtration medium including an electrospun nanofiber liquid filtration layer on a porous membrane substrate as taught herein, as along with one or more liquid filtration devices or supports for incorporating and using the composite filtration medium.

~~[0147]~~

[0160] The kit may contain one or more control solutions, and may optionally include various buffers useful in the methods of practicing the invention, such as wash buffers for eliminating reagents or eliminating non-specifically retained or bound material may optionally be included in the kit.

~~[0148]~~

[0161] Other optional kit reagents include an elution buffer. Each of the buffers may be provided in a separate container as a solution. Alternatively the buffers may be provided in dry form or as a powder and may be made up as a solution according to the user's desired application. In this case the buffers may be provided in packets.

~~[0149]~~

[0162] The kit may provide a power source in instances where the device is automated as well as a means of providing an external force such as a vacuum pump. The kit may also include instructions for using the

electrospun nanofiber containing liquid filtration medium, device, support or substrate, and/or for making up reagents suitable for use with the invention, and methods of practicing invention. Optional

software for recording and analyzing data obtained while practicing the methods of the invention or while using the device of the invention may also be included.

~~[0150]~~

[0163] The term "kit" includes, for example, each of the components combined in a single package, the components individually packaged and sold together, or the components presented together in a catalog (e.g., on the same page or double-page spread in the catalog).

~~[0151]~~

[0164] The disclosure set forth above may encompass multiple distinct inventions with independent utility. Although each of these inventions has been disclosed in its preferred form(s), the specific embodiments thereof as disclosed and illustrated herein are not to be considered in a limiting sense, because numerous variations are possible. The subject matter of the inventions includes all novel and nonobvious combinations and subcombinations of the various elements, features, functions, and/or properties disclosed herein. The following claims particularly point out certain combinations and subcombinations regarded as novel and nonobvious. Inventions embodied in other combinations and subcombinations of features, functions, elements, and/or properties may be claimed in applications claiming priority from this or a related application. Such claims, whether directed to a different invention or to the same invention, and whether broader, narrower, equal, or different in scope to the original claims, also are regarded as included within the subject matter of the inventions of the present disclosure.

WHAT IS CLAIMED IS:

1. A porous composite media comprising:

a porous membrane prefilter, and

a porous polymeric nanofiber retentive layer located on the porous membrane wherein the polymeric nanofiber has an average fiber diameter of 10 nm to 150 nm,

wherein the pore size of the porous nanofiber layer is smaller than the pore size of the porous membrane.

2. The porous composite media of claim 1, having a bubble point as measured with a ~~suitable fluid~~ liquid of at least 20% greater than the bubble point of the porous membrane alone.

3. The porous composite media of claim 1, wherein the porous membrane is asymmetric and includes a tight side.

~~4. The composite of claim 1, wherein the nanofiber layer is symmetric.~~

~~5.~~ 4. The porous composite media of claim 1, wherein the porous nanofiber layer is an electrospun mat.

~~6.~~ 5. The porous composite media of claim 1, wherein the porous nanofiber layer comprises a polymer selected from the group consisting of polyimide, aliphatic polyamide, aromatic polyamide, polysulfone, cellulose acetate, polyether sulfone, polyurethane, poly(urea urethane), polybenzimidazole, polyetherimide, polyacrylonitrile, poly(ethylene terephthalate), polypropylene, polyaniline, poly(ethylene oxide), polyethylene naphthalate), poly(butylene terephthalate), styrene butadiene rubber, polystyrene, poly(vinyl chloride), poly(vinyl alcohol), poly(vinylidene fluoride), poly(vinyl butylene), a copolymer, derivative compounds, or blends thereof.

~~7.~~ 6. The porous composite media of claim 1, wherein the porous nanofiber layer comprises an aliphatic polyamide.

~~8.~~ 7. The porous composite media of claim 1, wherein the porous nanofiber layer comprises a blend of polymers, copolymers, and mixtures thereof.

~~9.~~ 8. The porous composite media of claim 1, having a total thickness from ~~about~~ 10 μm to ~~about~~ 500 μm.

~~10.~~ 9. The porous composite media of claim 1, having a total thickness from ~~about~~ 50 μm to ~~about~~ 200 μm.

~~11.~~10. The porous composite media of claim 1, wherein the porous nanofiber layer is formed by a process selected from the group consisting of electrospinning and electroblowing.

~~12.~~11. The porous composite media of claim 1, wherein the porous nanofiber layer has a thickness from ~~about~~ 1 μm to ~~about~~ 200 μm.

~~13.~~12. The porous composite media of claim 1, wherein the porous nanofiber layer has a thickness from ~~about~~ 1 μm to ~~about~~ 100 μm.

~~14.~~13. The porous composite media of claim 1, wherein the porous nanofiber layer has a thickness from ~~about~~ 1 μm to ~~about~~ 25 μm.

~~15.~~14. The porous composite media of claim 1, wherein the porous membrane has a thickness from ~~about~~ 10 μm to ~~about~~ 500 μm.

~~16.~~15. The porous composite media of claim 1, wherein the porous membrane has a thickness from ~~about~~ 50 μm to ~~about~~ 200 μm.

~~17.~~16. The porous composite media of claim 1, wherein the porous membrane comprises one or more layers produced by solution phase inversion, thermally initiated phase separation, vapor induced phase separation, track etching, biaxial stretching, solvent etching and combinations thereof.

~~18.~~17. The porous composite media of claim 1 with mean flow bubble point for isopropanol from ~~about~~ 10 psi to ~~about~~ 130 psi.

~~19.~~18. A porous composite media for filtration comprising:

a porous asymmetric membrane having a tight side, an open side and a pore size increasing in size between the tight side and open side, and

a porous polymeric nanofiber layer located on the tight side wherein the polymeric nanofiber has an average fiber diameter of 10 nm to 150 nm, wherein the pore size on the tight side of the membrane is larger than the pore size of the polymeric nanofiber layer.

~~20. A composite filtration device for use in critical filtration comprising:~~

~~a prefilter having a porous asymmetric membrane having a tight side, an open side and a pore size increasing in size between the tight side and the open side, and~~

~~a retentive filter having a porous polymeric nanofiber layer located on the tight side of the asymmetric membrane, wherein the pore size on the tight side of the asymmetric membrane is larger than pore size of the polymeric nanofiber layer.~~

19. A filtration device for use in filtration comprising:

a composite media comprising:

a prefilter having a porous asymmetric membrane having a tight side, an open side and a pore size increasing in size between the tight side and the open side, and

a retentive filter having a porous polymeric electrospun nanofiber mat located on the tight side of the porous asymmetric membrane wherein the polymeric electrospun nanofiber has an average fiber diameter of 10 nm to 50 nm,

wherein the pore size on the tight side of the porous asymmetric membrane is larger than pore size of the porous polymeric electrospun nanofiber mat.

20. A filtration device for filtering microorganisms in a sample, comprising:

a composite filtration media comprising:

a porous membrane prefilter;

a porous polymeric nanofiber layer located on the porous membrane wherein the polymeric nanofiber has an average fiber diameter of 10

nm to 150 nm, the pore size of the porous nanofiberlayer being smaller than the pore size of the porous membrane;

wherein said composite filtration media is positioned in said device such that said porous membrane is upstream, in the direction of filtration, of said porous polymeric nanofiber layer, whereby said porous membrane provides prefiltration of said sample and said porous polymeric nanofiber layer provides critical filtration of said sample.

21. The filtration device in claim 20, wherein said composite media has a bubble point as measured with a liquid of at least 20% greater than the bubble point of the porous membrane alone.

22. The filtration device of claim 20, wherein the porous membrane is asymmetric and includes a tight side.

23. The filtration device of claim 20, wherein the porous nanofiber layer is an electrospun mat.

24. The filtration device of claim 20, wherein the porous nanofiber layer comprises a polymer selected from the group consisting of polyimide, aliphatic polyamide, polysulfone, cellulose acetate, polyether sulfone, polyurethane, poly(urea urethane), polypropylene, polyaniline, poly(ethylene oxide), poly(ethelene naphthalate), poly(butylene terephthalate), styrene butadiene rubber, polystyrene, poly(vinyl chloride), poly(vinyl alcohol), poly(vinylidene fluoride), (poly(vinyl butylene), a copolymer, derivative compounds, or blends thereof.

25. The filtration device of claim 20, wherein the porous nanofiber layer comprises an aliphatic polyamide.

26. The filtration device of claim 20, wherein the porous nanofiber layer comprises a blend of polymers, copolymers, or mixtures thereof.

27. The filtration device of claim 20, wherein said composite media has a total thickness from 10 μm to 500 μm

28. The filtration device of claim 20, wherein said composite media has a total thickness from 50 μm to 200 μm.

29. The filtration device of claim 20, wherein the porous nanofiber layer is formed by a process selected from the group consisting of electrospinning and electroblowing.

30. The filtration device of claim 20, wherein the porous nanofiber layer has a thickness from 1 μm to 200 μm.

31. The filtration device of claim 20, wherein the porous nanofiber layer has a thickness from 1 μm to 100 μm.

32. The filtration device of claim 20, wherein the porous nanofiber layer has a thickness from 1 μm to 25 μm.

33. The filtration device of claim 20, wherein the porous nanofiber layer has a thickness from 10 μm to 500 μm.

34. The filtration device of claim 20, wherein the porous nanofiber layer has a thickness from 50 μm to 200 μm.

35. The filtration device of claim 20, wherein the porous membrane comprises one or more layers produced by solution phase inversion, thermally initiated phase separation, vapour induced phase separation, track etching, biaxial stretching, solvent etching or combinations thereof.

36. The filtration device of claim 20, wherein said composite media has a mean flow bubble point for isopropanol from 10 psi to 130 psi.

37. The filtration device of claim 20, wherein said porous membrane prefilter is a porous asymmetric membrane having a tight side, an open side and a pore size increasing in size between the tight side and the open side, and said porous polymeric nanofiber layer is located on said tight side of said porous asymmetric membrane.