across the membrane section 115 through the pores 115 and recesses 130. The cavity 125 may have walls that slope towards the diffusive recesses as shown in the Figure. Such sloping may provide improved flow characteristics, by providing a more streamlined flow of a fluid forced across the structure, although in other embodiments the structure may have more square walls or shapes. By providing the cavity, several benefits may be provided including reducing the resistance through the diffusive recesses, and being able to provide a refreshed fluid more often across the recesses. For example, the filtration device may be used during a fluid filtration process including hemodialysis that may involve diffusion and/or ultrafiltration. By reducing the diffusive resistance, less membrane surface may be needed as will be explained below. Additionally, by improving the flow of fluid across the substrate, the refresh rate of the fluid being used may be improved.

FIG. 2A shows a top view of an array 200 of membranes 205 as may be disposed on a support structure according to embodiments of the present technology. The array may include various configurations of membranes 205 separated by dividers 210. The dividers 210 may provide several benefits including anchoring the pores located across the membranes, as well as providing structural support to the membrane 205 as a whole. The membrane structures 205 may be patterned over an area of a substrate that may include lengths as small as several microns, or as large as several millimeters. In some embodiments, the entire surface of the substrate may be patterned with the membrane structure, while alternatively less than the entire surface may be patterned to improve uniformity in thickness or configuration, for example.

FIG.2B shows a cross-sectional view along lines A-A of FIG. 2A of a filter fabricated according to embodiments of the present technology. This sectional view is not necessarily to scale, nor as would necessarily be located along the periphery of a substrate. In some embodiments a greater or fewer number of layers may be incorporated, for example, including an etch stop layer. This view is intended to aid one of skill in conceptualizing the structure of an embodiment of the filtration device without limiting the scope of the technology disclosed herein. The cross-section shows the location of apertures 215 formed through the membrane sections 205. In practice, the apertures may be formed in a pattern or array on the underside of the substrate to provide access through the membrane surface. The apertures 215 may be of any shape or size, and may be formed at particular intervals along the substrate to produce useable membranes at specific locations to provide a determined area of filtration across the device. The apertures may be formed as sections including one or more pores through the membrane, a diffusive recess, and a cavity. Exemplary recesses may

WHAT IS CLAIMED IS:

1. A microfabricated filtration device comprising:

a planar membrane section comprising a plurality of pores, each pore having a width of less than about 100 nm; and

a support section comprising a substrate coupled with the membrane section, the substrate comprising a plurality of thick portions and a plurality of recesses between the thick portions in a second thin portion that is between adjacent thick portions, wherein the recesses are in communication with the pores in the plurality of pores.

2. The microfabricated filtration device of claim 1, wherein the thin portion of the substrate comprises a thickness of between about 10 μm and about 100 μm.

3. The microfabricated filtration device of claim 2, wherein the thin portion of the substrate comprises a thickness of between about 20 μm and about 50 μm.

4. The microfabricated filtration device of claim 1, further comprising an additional layer of material between the substrate and the membrane section.

5. The microfabricated filtration device of claim 4, wherein the additional layer of material comprises a dielectric material.

6. A method of using a microfabricated filtration device, the method comprising:

delivering a fluid to a filtration device, the filtration device including:

a planar membrane section comprising a plurality of pores, each pore having a width of less than about 100 nm, and

a support section comprising a substrate coupled with the membrane section, the substrate comprising a plurality of thick portions and a plurality of recesses between the thick portions in a second thin portion that is between adjacent thick portions, wherein the recesses are in communication with the pores in the plurality of pores;

flowing the fluid over the planar membrane section to produce a filtered fluid; and

delivering the filtered fluid from the filtration device.

7. The method of claim 6, wherein the filtration device further includes a first channel in fluid communication with the membrane section of the filtration device, and a second channel in fluid communication with the support section of the filtration device.

8. The method of claim 7, further comprising:

flowing the first fluid through the first channel in a first direction of flow;

flowing a second fluid through the second channel in a direction of flow that is counter-current to the first direction of flow;

transporting solutes across the membrane section between the first fluid and the second fluid.

9. The method of claim 8, further comprising:

pumping the first and second fluid through the filtration device to maintain equal pressure across the membrane section of the filtration device.

10. The method of claim 9, further comprising:

incorporating an additional material into the first fluid prior to delivering the fluid to the filtration device.

11. A microfabricated filtration device comprising:

a membrane section having a thickness of less than about 1 μm in height and defining a plurality of pores having a width of less than about 10 nm; and

a support section comprising a substrate coupled with the membrane section, the substrate at least partially defining a cavity and a plurality of recesses, wherein:

the cavity is located in the backside of the substrate and is in communication with the plurality of recesses, wherein the recesses are in communication with the defined pores, and

the plurality of recesses are defined by portions of the substrate such that each portion of the substrate located between any two recesses comprises a height of about 50 μm or less.

12. The microfabricated filtration device of claim 11, wherein the support section further comprises at least one additional layer of material disposed between the substrate and membrane section, and wherein the at least one additional layer defines a portion of the recesses.

13. The microfabricated filtration device of claim 11, wherein the portions of the substrate located between any two recesses comprise a height of about 20 μm or more.

14. The microfabricated filtration device of claim 11, wherein the plurality of recesses comprise a diameter of less than about 150 μm.

15. The microfabricated filtration device of claim 11, wherein the substrate comprises a single homogenous layer of material.

16. The microfabricated filtration device of claim 11, wherein the cavity comprises inwardly sloping walls toward the plurality of recesses.

17. The microfabricated filtration device of claim 11, wherein the plurality of recesses comprise length by width measurements of about 100 μm by about 50 μm.

18. A method of making a microfabricated filtration device, the method comprising:

depositing a dielectric layer over a semiconductor substrate;

forming a first layer of a membrane material on the dielectric layer and etching a pattern in the first membrane material layer;

forming a sacrificial dielectric layer over the patterned first membrane material layer and forming a second membrane material layer over the sacrificial dielectric layer;

forming a protective layer over the second membrane material layer;

etching the substrate with a first etchant process that produces a cavity that does not extend to the layers of membrane material;

etching the substrate with a second etchant process that forms a plurality of recesses through the remaining portion of the substrate; and

etching the filtration device with a third etchant process that removes the sacrificial dielectric layer forming pores through the membrane material layers, which provides access to the recesses such that the combination of the pores, recesses, and the cavity produce apertures through the filtration device.

19. The method of claim 18, wherein the first etchant process comprises a wet etchant.

20. The method of claim 19, wherein the first and second etchant processes comprise a reactive ion etch.

21. A method of filtering a fluid, comprising

delivering a first fluid into a filtration device;

flowing the first fluid across a front side of a filtration member located in the filtration device that includes a membrane section having a thickness of less than about 1 μm in height and defining a plurality of pores with each pore having a width of less than about 50 nm;

flowing a second fluid across a backside of the filtration member located in the filtration device that includes a support section comprising a substrate coupled with the membrane section, the substrate at least partially defining a cavity and a plurality of recesses, wherein:

the cavity is located in the backside of the substrate and is in communication with the plurality of recesses, wherein the recesses are in communication with the defined pores,

the plurality of recesses are defined by portions of the substrate such that each portion of the substrate located between any two recesses comprises a height of about 50 μm or less, and

the second fluid flows through the cavity to provide the second fluid to the recesses so that diffusive transport occurs across the membrane section between the first and second fluids to produce filtered first fluid; and

transferring the filtered first fluid from the filtration device.

across the membrane section 115 through the pores 120 and recesses 130. The cavity 125 may have walls that slope towards the diffusive recesses as shown in the Figure. Such sloping may provide improved flow characteristics, by providing a more streamlined flow of a fluid forced across the structure, although in other embodiments the structure may have more square walls or shapes. By providing the cavity, several benefits may be provided including reducing the resistance through the diffusive recesses, and being able to provide a refreshed fluid more often across the recesses. For example, the filtration device may be used during a fluid filtration process including hemodialysis that may involve diffusion and/or ultrafiltration. By reducing the diffusive resistance, less membrane surface may be needed as will be explained below. Additionally, by improving the flow of fluid across the substrate, the refresh rate of the fluid being used may be improved.

FIG. 2A shows a top view of an array 200 of membranes 205 as may be disposed on a support structure according to embodiments of the present technology. The array may include various configurations of membranes 205 separated by support structures 210. The support structures 210 may provide several benefits including anchoring the pores located across the membranes, as well as providing structural support to the membrane 205 as a whole. The membrane structures 205 may be patterned over an area of a substrate that may include lengths as small as several microns, or as large as several millimeters. In some embodiments, the entire surface of the substrate may be patterned with the membrane structure, while alternatively less than the entire surface may be patterned to improve uniformity in thickness or configuration, for example.

FIG.2B shows a cross-sectional view along lines A-A of FIG. 2A of a filter fabricated according to embodiments of the present technology. This sectional view is not necessarily to scale, nor as would necessarily be located along the periphery of a substrate. In some embodiments a greater or fewer number of layers may be incorporated, for example, including an etch stop layer. This view is intended to aid one of skill in conceptualizing the structure of an embodiment of the filtration device without limiting the scope of the technology disclosed herein. The cross-section shows the location of apertures 215 formed through the membrane sections 205. In practice, the apertures may be formed in a pattern or array on the underside of the substrate to provide access through the membrane surface. The apertures 215 may be of any shape or size, and may be formed at particular intervals along the substrate to produce useable membranes at specific locations to provide a determined area of filtration across the device. The apertures may be formed as sections including one or more pores through the membrane, a diffusive recess, and a cavity. Exemplary recesses may

What is claimed is:

1. A microfabricated filtration device comprising:

a planar membrane section comprising a plurality of pores, each pore having a width of less than about 100 nm;

an additional layer of material coupled with the planar membrane section; and

a support section coupled with the additional layer of material along a first surface of the support section, wherein the support section defines a cavity within a second surface of the support section opposite the first surface of the support section, wherein the cavity provides access to a plurality of recesses defined within the support section and the additional layer of material, wherein the plurality of recesses provide access to the plurality of pores, and wherein the plurality of recesses are separated from one another by dividers comprising portions of the support section and additional layer of material coupled with the planar membrane.

2. The microfabricated filtration device of claim 1, wherein the dividers comprise a thickness of between about 10 μm and about 100 μm.

3. The microfabricated filtration device of claim 2, wherein the dividers comprise a thickness of between about 20 μm and about 50 μm.

4. The microfabricated filtration device of claim 1, wherein the additional layer of material comprises a dielectric material.

5. A method of using a microfabricated filtration device, the method comprising:

delivering a fluid to a filtration device, the filtration device including:

a planar membrane section comprising a plurality of pores, each pore having a width of less than about 100 nm,

an additional layer of material coupled with the planar membrane section, and

a support section coupled with the additional layer of material along a first surface of the support section, wherein the support section defines a cavity within a second surface of the support section opposite the first surface of the support

section, wherein the cavity provides access to a plurality of recesses defined within the support section and the additional layer of material, wherein the plurality of recesses provide access to the plurality of pores, and wherein the plurality of recesses are separated from one another by dividers comprising portions of the support section and additional layer of material coupled with the planar membrane;

flowing the fluid over the planar membrane section to produce a filtered fluid; and

delivering the filtered fluid from the filtration device.

6. The method of claim 5, wherein the filtration device further includes a first channel in fluid communication with the membrane section of the filtration device, and a second channel in fluid communication with the support section of the filtration device.

7. The method of claim 6, further comprising:

flowing the first fluid through the first channel in a first direction of flow;

flowing a second fluid through the second channel in a direction of flow that is counter-current to the first direction of flow;

transporting solutes across the membrane section between the first fluid and the second fluid.

8. The method of claim 7, further comprising:

pumping the first and second fluid through the filtration device to maintain equal pressure across the membrane section of the filtration device.

9. The method of claim 8, further comprising:

incorporating an additional material into the first fluid prior to delivering the fluid to the filtration device.

10. The microfabricated filtration device of claims 1 or 6, wherein the pores are characterized by a rectangular shape, having a width of less than 10 nm.

11. The microfabricated filtration device of claims 1 or 6, wherein the membrane comprises polysilicon.

12. The microfabricated filtration device of claims 1 or 6, wherein the recesses are characterized by a width between dividers of 60 μm and a height of 120 μm.